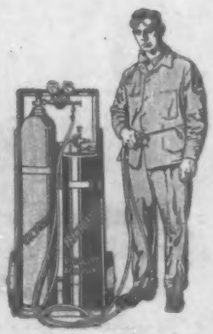
*Of this issue more than 4000 copies were printed*

# The Welding Engineer

Vol. II. Chicago 608 S. Dearborn St. JANUARY, 1917 $2.00 per year in U. S. $2.50 per year abroad No. 1


## Oxy-Acetylene Welding and Cutting

## Pays larger profits—opens a wider field for welding



The Prest-O-Lite Oxy-Acetylene Process has an important place in every shop and factory where welding is done—even where other welding methods are profitably employed.

It will handle certain work which no other process can touch—increases your opportunities for savings on many kinds of metal joining—in repair, construction or manufacturing work.

In different fields of the metal working industry, old-fashioned, wasteful methods have been discarded for the more efficient, profitable and convenient oxy-acetylene process, without any serious changes in established systems of production or heavy investment in expensive one-purpose equipment.

***We will gladly send you literature and data showing actual instances of work done and savings made—possible uses in YOUR plant.***

The Prest-O-Lite Co., Inc.

*The World's Largest Makers of Dissolved Acetylene*

U. S. Main Office and Factory, 851 Speedway, Indianapolis, Ind.
Canadian Main Office and Factory, Merritton, Ont.

Prest-O-Lite PROCESS


*Alphabetical Index to Advertisers and Buyers' Index, Page 4.

# The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

**Oxweld Equipment** includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

**Oxweld Supplies** are made up in accordance with the formulae of our metallurgists—tested by analysis in our laboratory and their merits tested out and proven by our expert welders in actual shop practice. We guarantee **OXWELD SUPPLIES,** when used by competent welders, to produce better results than any others known to the art today.

Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

***Write us for information on any class of Welding or Cutting Work***

## Oxweld Acetylene Company

**CHICAGO**
**36th St. and Jasper Place**

**NEWARK, N. J.**
**6460-680 Frelinghuysen Ave.**

**LOS ANGELES**
**654-656 Pacific Electric Bldg.**

## WELDERS' GOGGLE No. 3

White non-rusting metal, folding screens, all metal parts covered to prevent the frame from getting heated and burning the skin. Fastened on by an elastic head-band.

No. 3. Mounted with first quality, gray green glass .....$1.50 each
Mounted with the new American Noviweld glass .....$2.00 each
Quantity prices upon application

After experimenting for two years we have succeeded in producing a glass especially for Welders, equal, if not superior, to the German make. The Gray green glass used in our goggles is an American product.

The above goggles furnished with light smoked, blue, amber or clear white glasses

**WILLIAM C. ADAMS**
Manufacturer, Importer and Wholesale Dealer In
Welding Goggles and Protection Glasses
332 BOYLSTON STREET
BOSTON - - - MASS., U. S. A.
Write for Catalogue. Samples Submitted

## ASBESTOS

Gloves,
Mittens,
Leggings,
Aprons,
Pants,
Coats,
Fingers,
Patching Pieces,
Specialties,
Cloth,
Yarns.

We manufacture and are prepared to furnish promptly, at reasonable cost, asbestos garments of all descriptions. They are all treated by our own special process, which prevents the nap rubbing off, giving added life and tensile strength to fabric.

We are prepared to furnish anything in the asbestos line.

**MIKESELL BROTHERS COMPANY**
Dept. S 178 N. La Salle St., Chicago

## Huge Stacks Felled In Record Time

By Means of

**Imperial**
**OXY-ACETYLENE EQUIPMENT**

The gigantic task of dismantling the huge Harrison Street Plant of the Commonwealth-Edison Company in Chicago was accomplished in record time by means of four outfits of

**IMPERIAL WELDING CUTTING EQUIPMENT**
**OXY-ACETYLENE PROCESS**

The base of each of the eight stacks was cut by the flame in carefully selected places so as to undermine it. Mammoth engines, generators, fly-wheels, forty-two 360 H. P. boilers, coal hoppers—seemingly immovable, have also been reduced to small, easily handled pieces of scrap, as if by magic, by the Imperial Cutting Torch.

And so the good word of Imperial performance on big jobs goes along—first in SAFETY, SPEED of ACCOMPLISHMENT and ECONOMY of OPERATION.

If you are planning to purchase new equipment or are not satisfied with your present outfit, end all your troubles by getting an Imperial Equipment NOW.

Write for catalogue giving pictures of work actually accomplished, cost of operation and other valuable data.

**IMPERIAL BRASS MFG. CO.**
522 So. Racine Ave. :: CHICAGO

# Buyers' Index

*Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.*

**ACETYLENE (Compressed in Cylinders)**
Commercial Acetylene Welding Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

**ACETYLENE GENERATORS**
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Indiana Oxygen Co.
The Harris Calorific Co.
Metals Welding Plant
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.

**ALUMINUM FILLER RODS**
American Welding Co.
Fidelity Brass Mfg. Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Mach. Co.
United States Welding Co.
Universal Oxygen Co.

**ALUMINUM FLUX**
American Welding Co.
Fidelity Brass Mfg. Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**ALUMINUM SOLDER**
National Solder Co.
So. Luminum Mfg. & Eng. Co.

**ANNEALING FURNACES**
Buffalo Dental Mfg. Co.
Universal Oxygen Co.

**APRONS (Asbestos)**

**ASBESTOS GLOVES**

**ASBESTOS SHEET PAPER**
American Oxygen Co.
Davis-Bournonville Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**BLOW TORCHES (Acetylene)**
American Welding Co.
American Oxygen Co.
Fidelity Brass Mfg. Co.
Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Indiana Oxygen Co.
Metals Welding Plant
The Alexander Milburn Co.
The Prest-O-Lite Co.

**BOOKS (Relating to Welding)**
The Welding Engineer

**BRASS AND BRONZE FLUX**
American Welding Co.
American Oxygen Co.
Hauck Mfg. Co.
Fidelity Brass Mfg. Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
United States Welding Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

**BRASS SPELTER WIRE**
American Oxygen Co.
Indiana Oxygen Co.
Universal Oxygen Co.

**BRAZING OUTFITS**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.

**BRONZE FILLER RODS**
American Oxygen Co.
Hauck Mfg. Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Fidelity Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**BUTT WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**CARBIDE (Calcium)**
American Carbolite Sales Co.
Union Carbide Sales Co.
Canada Carbide Sales Co.

**CARBON REMOVING TORCHES**
American Welding Co.
American Oxygen Co.
The Bastian-Blessing Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
Ideal Bronze Co.
General Welding & Equipment Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Fidelity Brass Mfg. Co.
Indiana Oxygen Co.
Messer & Co.
Metals Welding Plant
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Mach. Co.
Universal Oxygen Co.

**CAST IRON FILLER RODS AND FLUX**
American Welding Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**ELECTRIC ARC WELDING OUTFITS**
Westinghouse Electric & Mfg. Co.
General Electric Co.

**ELECTROLYTIC OXYGEN PLANTS**
Universal Oxygen Co.

**FILLER RODS (Aluminum)**
American Welding Co.
American Oxygen Co.
Hauck Mfg. Co.
Indiana Oxygen Co.
United States Welding Co.
The Prest-O-Lite Co.

**FILLER RODS (Swedish Iron)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Apex Steel Corporation.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

**FILLER RODS (Tobin Bronze)**
American Welding Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**FILLER RODS (Vanadium Steel)**
American Welding Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Fidelity Brass Mfg. Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**FIREPROOF PLASTIC**
Fidelity Brass Mfg. Co.
Bermo Welding Apparatus Co.

**FLUX WELDERS (Electric)**
Westinghouse Electric & Mfg. Co.

**FURNACES (Annealing)**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Universal Oxygen Co.

**GASOLINE PREHEATING FURNACES**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.

**GAS BURNERS (Preheating)**
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.

**GLOVES (Asbestos)**
Mikesell Bros. Co.
United States Welding Co.

**GLOVES (Welders Asbestos)**
American Welding Co.
American Oxygen Co.
Davis-Bournonville Co.
Indiana Oxygen Co.
Mikesell Bros. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.

**HARDENING FURNACES**
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.

**HOSE (Oxygen and Acetylene)**
American Welding Co.
American Oxygen Co.
Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
The Prest-O-Lite Co.
United States Welding Co.
Universal Oxygen Co.

**HOSE UNIONS**
Bermo Welding Apparatus Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.

**HYDROGEN**
American Oxygen Co.
Carbo-Hydrogen Co.
Indiana Oxygen Co.
Universal Oxygen Co.

**KEROSENE PREHEATING TORCHES**
Alger Supply Co.
Goldschmidt Thermit Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Fidelity Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.

**NEEDLE VALVES**
American Oxygen Co.
Indiana Oxygen Co.
The Bastian-Blessing Co.
Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.

# Daddy Always Wears Goggles at His Work; Even the Babies Know Why

In providing your workmen with King's Saniglas Goggles, you protect them, their families and yourself.

Standardized by leading industrial plants in the United States.

## JULIUS KING OPTICAL CO.

10 Maiden Lane
NEW YORK

7 West Madison St.
CHICAGO

**OIL BURNERS (Preheating)**
Alger Supply Co.
Oxweld Acetylene Co.
Fidelity Brass Mfg. Co.
Superior Oxy-Acetylene Mach. Co.

**OXYGEN (Compressed in Cylinders)**
American Oxygen Co.
Indiana Oxygen Co.
Logansport Oxygen Co.
Ohio Electrolytic Oxygen Co.
The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.

**PIPE WELDING**
Goldschmitt Thermit Co.

**PHOTOGRAPHS**
Chicago Architectural Photographing Co., (Specialists in photographs relating to the welding industry)

**PLASTIC (Fireproof)**

**PRESSURE GAUGES**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Bastian & Blessing Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
United States Welding Co.
Universal Oxygen Co.

**RAILROADS—Special Service for**
American Oxygen Co.
Indiana Oxygen Co.
Oxweld Railroad Service Co.

**REGULATING VALVES (Acetylene)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
The Bastian-Blessing Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co., Inc.
United States Welding Co.
Universal Oxygen Co.

**REGULATING VALVES (Hydrogen)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
The Bastian-Blessing Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
The Prest-O-Lite Co.
The Imperial Brass Mfg. Co.
Fidelity Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

**REGULATING VALVES (Oxygen)**
The Bastian-Blessing Co.
American Welding Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Fidelity Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**SCHOOLS OF WELDING**
Michigan State Auto School.

**SEAM WELDERS (Electric)**
General Electric Co.
Westinghouse Electric & Mfg. Co.

**SEAM WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**SPOT WELDERS (Electric Resistance)**
Thomson Electric Welding Co.

**TANK CONNECTIONS (Oxygen and Acetylene Adaptors)**
Superior Oxy-Acetylene Machine Co.

**THERMALENE-GAS**
The Thermalene Co.

**THERMIT WELDING**
Goldschmidt-Thermit Co.

**TORCHES (Gasoline and Kerosene Preheating)**
American Welding Co.
Alger Supply Co.
Buffalo Dental Mfg. Co.
General Welding & Eq. Co.
The Bishop-Babcock-Becker Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Westinghouse Electric & Mfg. Co.

**TORCHES (Oxy-Acetylene Cutting)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Bermo Welding Apparatus Co.
Ideal Bronze Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
General Welding & Eq. Co.
Fidelity Brass Mfg. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer & Co.
Welding Supply Co.
K-G Welding & Cutting Co.
Metals Welding Plant
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

**TORCHES (Oxy-Acetylene Welding)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Ideal Bronze Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Messer & Co.
Welding Supply Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Metals Welding Plant
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

**TORCHES (Oxy-Hydrogen Cutting)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Bermo Welding Apparatus Co.
The Bishop-Babcock-Becker Co.
Fidelity Brass Mfg. Co.
Davis-Bournonville Co.
Messer & Co.
Welding Supply Co.
General Welding & Eq. Co.
Ideal Bronze Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Alexander Milburn Co.
The Imperial Brass Mfg. Co.
Vulcan Process Co.
Metals Welding Plant
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

**TORCHES (Oxy-Hydrogen Welding)**
American Welding Co.
American Oxygen Co.
Vulcan Process Co.
Indiana Oxygen Co.
Bermo Welding Apparatus Co.
Messer & Co.
Welding Supply Co.
Ideal Bronze Co.
The Bishop-Babcock-Becker Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Vulcan Process Co.
General Welding & Eq. Co.
The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
Metals Welding Plant
The Imperial Brass Mfg. Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
United States Welding Co.
Universal Oxygen Co.

**TORCHES (Special to Order)**
American Welding Co.
Bermo Welding Apparatus Co.
Fidelity Brass Mfg. Co.
The Bishop-Babcock-Becker Co.
The Harris Calorific Co.
Superior Oxy-Acetylene Machine Co.

**TRUCKS (Cylinder Carriers)**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
Davis-Burnonville Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**VALVES (For Oxygen Cylinders)**
American Oxygen Co.
Indiana Oxygen Co.
The Bastian-Blessing Co.
International Oxygen Co.
Universal Oxygen Co.

**WELDING (Electric Resistance-Custom Work)**
Thomson Electric Welding Co.

**WELDERS' GOGGLES**
American Welding Co.
American Oxygen Co.
Indiana Oxygen Co.
William C. Adams.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Julius King Optical Co.
Fidelity Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

**WELDING (Oxygen for)**
American Oxygen Co.
Indiana Oxygen Co.
International Oxygen Co.
The Linde Air Products Co.
Universal Oxygen Co.

# ALPHABETICAL INDEX TO ADVERTISERS


**A**
Adams, William C..... 3
Alger Supply Company..... 13
American Carborilite Sales Co..... 15
American Oxygen Co..... 12
Apex Steel Corporation..... 11
American Welding Co..... 10

**B**
The Bastian-Blessing Co..... 55
Bermo Welding Apparatus Co..... 53
The Bishop-Babcock-Becker Co..... 51
Buffalo Dental Mfg. Co..... 17

**C**
Canada Carbide Sales Co..... 11
Carbo-Hydrogen Co..... 10
Chicago Eye Shield Co..... 51
Commercial Acetylene Welding Co..... 47

**D**
Davis-Bournonville Co..... 3
M. Keith Dunham..... 47

**F**
Fidelity Brass Mfg. Co..... 49

**G**
General Welding & Equipment Co..... 52
General Electric Co..... 16
Goldschmidt Thermit Co.....Back cover

**H**
The Harris Calorific Co..... 51
Henderson-Willis Welding & Cutting Co... 15
F. A. Hardy & Co..... 12
Hauck Mfg. Co..... 49

**I**
Ideal Bronze Co..... 53
Imperial Brass Mfg. Co..... 3
International Oxygen Co.....
Indiana Oxygen Co..... 13
Indiana Oxygen Co..... 14

**K**
K-G Welding & Cutting Co..... 13
Julius King Optical Co..... 5

**L**
Linde Air Products Co..... 18
Logansport Oxygen Co..... 15

**M**
Messer & Co..... 15
Michigan State Auto School..... 53
Mikesell Bros. Co..... 3
The Alexander Milburn Co..... 13
The Metals Welding Plant..... 14

**N**
National Solder Co..... 11

**O**
Ohio Electrolytic Oxygen Co..... 15
Oxweld Acetylene Co..... 2
Oxweld Railroad Service Co..... 13

**P**
Prest-O-Lite Co., Inc.....Front cover

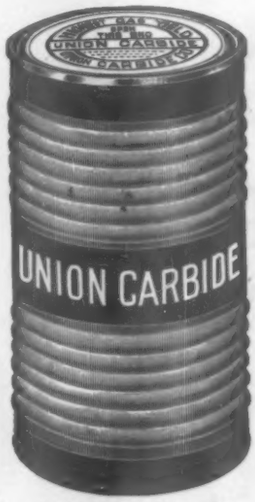
**S**
So. Luminum Mfg. & Eng. Co..... 53
Superior Oxy-Acetylene Machine Co..... 53
Swift & Co..... 12

**T**
The Thermalene Co..... 9
Thomson Electric Welding Co..... 13

**U**
Union Carbide Sales Co..... 7
United States Welding Co..... 53
Universal Oxygen Co..... 15
U. S. Gauge Co..... 8

**V**
Vulcan Process Co..... 17

**W**
Westinghouse Electric & Mfg. Co..... 43
Welding Supply Co..... 8
Winfield Elec. Weld. Mach. Co..... 49




Packed in Blue and Gray Drums

# Union Carbide Sales Company

**New York City, 42nd St. Building** — **Chicago, Ill., Peoples Gas Building** — **San Francisco, Cal., Kohl Building**

*SOLE DISTRIBUTORS OF*

# UNION CARBIDE

**"World's Best Quality—Highest Gas Yield"**

## For Oxy-Acetylene Welding Plants

**Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants**

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

**3½ x 2 in.** —a large size.

**2 x ½ in.** —a medium size.

**1¼ x ⅜ in.** —an intermediate size.

**¼ x 1/12 in.** —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

**ALABAMA**
Birmingham—1916 Morris Ave.
Mobile—262-268 S. Water St.
Montgomery—114 N. Perry St.
**ARIZONA**
Phoenix—42 S. Central Ave.
**ARKANSAS**
Fort Smith—109-123 So. Ninth St.
**CALIFORNIA**
Eureka—109 Second St.
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
**COLORADO**
Denver—Nineteenth and Wazee Sts.
Victor—Third and Diamond Sts.
**CONNECTICUT**
Hartford—377 Main St.
**DISTRICT OF COLUMBIA**
Washington—Maryland Ave. and 9th St., S. W.
**FLORIDA**
Jacksonville—106 E. Forsyth St.
Tampa—418 Tampa St.
**GEORGIA**
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
**ILLINOIS**
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—721-731 So. Washington St.
Marion—215 S. Granite St., Box 747.
Monmouth—601 S. First St.
Quincy—223 S. Eighth St.
Streator—702 East Elm St.
**INDIANA**
Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
**IOWA**
Des Moines—117-119 Fifth St.
Dubuque—8th and Washington Sts.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 393.
**KANSAS**
Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—721 Beacon Building.
**KENTUCKY**
Louisville—126 E. Main St.
Middlesboro—
**LOUISIANA**
New Orleans—819-21 Julia St.
**MAINE**
Portland—202 Commercial St.
**MARYLAND**
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.
**MASSACHUSETTS**
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.
**MICHIGAN**
Detroit—Jefferson Ave. and Orleans St.
Grand Rapids—135 Ottawa Ave., N. Y.
Hancock—First National Bank Bldg.
Iron Mountain—215 E. A St.
Jackson—172 South Water St.
Saginaw—1902 N. Michigan Ave.
Sault Ste. Marie.
**MINNESOTA**
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.
**MISSISSIPPI**
Vicksburg—1312 Washington St.
**MISSOURI**
Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)
**NEBRASKA**
Omaha—1907-9-11 Jones St., Union Sta. P. O.
**NEW HAMPSHIRE**
Concord—77 South Main St.
**NEW JERSEY**
Camden—Delaware Ave. and Cooper St.
Jersey City—554-56 Henderson St.
**NEW YORK**
Albany—Montgomery and Colonie Sts.
Binghamton—31 Jarvis St.
Geneva—Exchange St. and Railroad Pl.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York City—42nd St. Building.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Roscoe.
Utica—127 Hotel St.
Watertown—438 Court St.
Whitehall—57 Canal St.
**NORTH CAROLINA**
Wilmington—Room 16 Masonic Temple, 13 N. Front St.
**NORTH DAKOTA**
Fargo—17-19 Broadway.
**OHIO** Cincinnati—62-65 Plum St.
Cleveland—601 The Citizens' Building.
Columbus—310 Dublin Ave.
Dayton—812-828 E. First St.
Lima—328 East High St.
Toledo—414 S. Erie St.
Zanesville—Main and Second Sts.
**OKLAHOMA**
Oklahoma City—27-29 E. Grand Ave.
**OREGON**
Portland—Fifteenth and Hoyt Sts.
**PENNSYLVANIA**
Beaver.
Du Bois—Weber Ave. and Franklin St.
Erie—1426 Chestnut St.
Harrisburg—627 Walnut St.
Johnstown—129 Jackson St.
Pittsburgh—32nd St. and Penn. R. R.
Pottsville—Railroad and Sanderson Sts.
Scranton—4 Cliff St.
Shamokin—46 West Independence St.
Williamsport—Canal and Court Sts.
**RHODE ISLAND** ..... ..... ....
Providence—Allen's Ave., P. O. Box 419.
**SOUTH CAROLINA**
Charleston—153 Church St.
**TENNESSEE**
Chattanooga—700 E. Tenth St.
Knoxville—426 West Depot Ave.
Memphis—471 South Main St.
Nashville—105-107-109 Broadway.
**TEXAS**
Dallas—802-810 Cadiz St.
El Paso—900 Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—632 S. 7th St.
**UTAH**
Salt Lake City—118 W. Second South St.
**VERMONT**
Burlington—College and Champlain Sts.
**VIRGINIA**
Lynchburg—1324 Commerce St.
Norfolk—Cor. First and Front Sts.
Richmond—18th and Cary Sts.
**WEST VIRGINIA**
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" Street.
Huntington—820 3rd Avenue.
**WASHINGTON**
Seattle—1102 First Ave.
Spokane—646 Peyton Building.
**WISCONSIN**
La Crosse—Front and King Streets.
Madison—309 East Wilson St.
Milwaukee—120-134 Jefferson St.

We recommend our customers to **select from the list, the city** from which the quickest delivery and lowest freight rate can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**

Please address request for information or special correspondence to either the Chicago or New York office.

# Welding Supply Co., Inc.

132 Nassau Street, New York

**Seamless and Welded TANKS**

**Cast, Forged and Pressed High Pressure Cylinder VALVES**

**Ask for Our Valve Catalog**

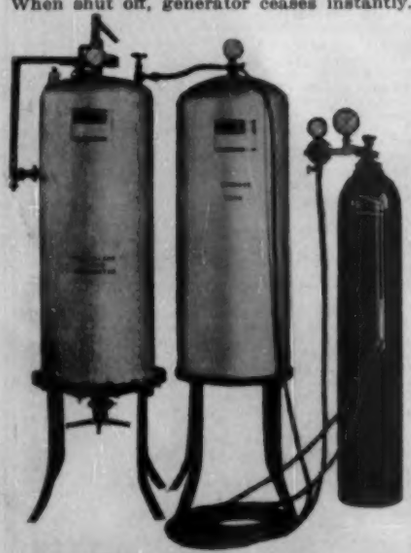
**Welding Apparatus and Supplies**

THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

## The Oxy-Thermalene Method
### of Welding, Cutting, Brazing, Etc.

The only Acetylene Oil Gas generator in the world. Saves 25% on gas and oxygen. First class references. We also sell complete Oxy-Acetylene equipment for dissolved Acetylene for $42.00.

Thermalene gas in conjunction with Oxygen gas produces the ideal flame for welding and cutting. There is no loss of time due to shortage of gas. The generator works only when you work. When shut off, generator ceases instantly.



Thermaline will not produce faulty welds due to impure and moist gas. The generator may be mounted on a truck and made portable.

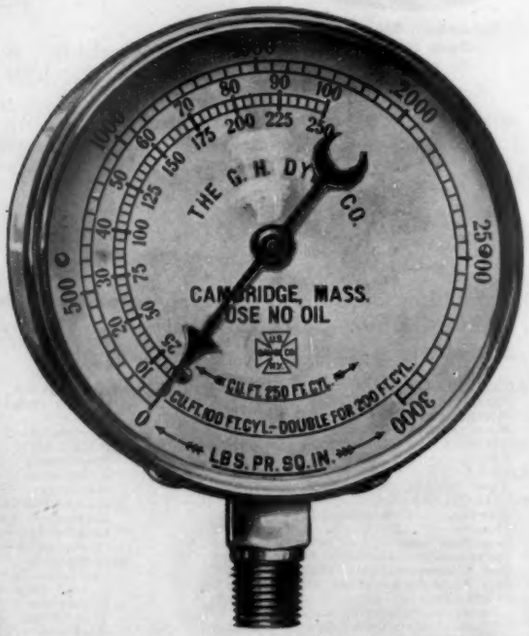
Thermaline Gas, being heavier and richer than Acetylene and other gases, has more body, producing a softer non-oxidizing flame, which assures a more uniform weld and a cleaner cut, without burning or making the metal brittle.

Write for full information, catalog and prices.

**THE THERMALENE COMPANY**
Chicago Heights, Ill.

THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

# U.S. Gauge Company
## New York




The G. H. Dyer Co. has adopted the U. S. GAUGE as standard on their equipment. Its record in service, together with distinctive patented safety features commend it to the best trade.

## New York, 67 Wall St.

Chicago, Clark Street Bridge.
San Francisco, 681 Market Street.
Detroit, 42 W. Larned Street.
Montreal, Board of Trade.

**Works: Sellersville, Pa.**

# 75% Efficiency is 33⅓% In-efficient

A man or a machine only 75% efficient must do one-third better to be 100% efficient.

100% efficiency is not necessarily perfection—but, the standard of 100% is essentially the "best obtainable"—therefore, it is the basis for comparison of less efficient performance.

One of the most prominent industries in the United States, employing a large amount of Davis-Bournonville apparatus with much success, recently said—bantering the salesman about the price—"When we can get welding torches 75% as efficient as the Davis-Bournonville torches, at sufficiently lower price, we will consider them!"

Consider, yes! But the chances are they will not willingly employ tools, machines or men, that ought to be and could be 33⅓% more efficient than they are. This would mean that the 75% efficient man does in four days what he ought to do in three days—that the 75% efficient welding torch should give one-third better results than it does—and, if efficiency is based on both gas consumption and manual performance, that four tanks of oxygen are used when three would do the work, four hours' time consumed when three should have been enough, or, the welded job is only three-fourths as good as it ought to be—

*also, 75% efficiency may mean loss of prestige and reputation for efficient performance.*

Davis-Bournonville oxy-acetylene and oxy-hydrogen apparatus is the standard for efficiency, and has been since this company introduced the positive-pressure process of oxy-acetylene welding to the metal working industries in the United States, ten years ago—because it provides the highest efficiency obtainable, with the greatest development of apparatus, and most extended application in the metal working trades, and the widest range of equipment made for the use of the oxy-acetylene and oxy-hydrogen processes.

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

***Leads the World in Range, Efficiency and Apparatus in Successful Use***

Davis-Bournonville Welding and Cutting Apparatus is in successful use by the most prominent concerns in the United States and Canada engaged in iron and steel production and metal working—foundries, rolling mills, ship yards, navy yards, scrap yards, railroad shops, locomotive and car shops, steel furniture, sash and door plants, tube mills, pipe and pipe bending works, by automobile and motor truck makers, manufacturers of automobile metal bodies, ornamental iron workers, on construction work and for wrecking, and in hundreds of small and large repair shops and garages, for welding and building up broken and worn castings.

(Our No. 3 factory building was completed and occupied in mid-summer, 1916, affording 30,000 additional square feet of floor space. We are now adding two more stories with 20,000 square feet more floor space, to keep up with the demand for "Davis apparatus.")

## Davis-Bournonville Company

**General Office and Factory: Jersey City, N. J.**

**Sales Offices: New York, Chicago, Boston, Philadelphia, Pittsburgh, Cleveland, Detroit, St. Louis, San Francisco, Toronto**

# A Series *of* Lessons for Welders

**No. 1**
Keep these lessons. Paste them in a scrap book.

Foreword: Helpful information is a vital necessity to the welder, the man who has mastered the primary problems of the art. He finds that he is constantly being confronted with new and perplexing problems, requiring the application of both skill and intelligence. It is plain, therefore, that he who uses his head, as well as his hands, will excel in the art of welding successfully. In this space I am going to supplement, each month, the splendid work which is being done by The Welding Engineer, and publish a systematic series of helpful suggestions, intended both for the welder and the man who is about to take up welding. I shall also be glad to answer promptly any questions welders may care to ask.

Bear in mind that I do not profess to be the final authority in welding. What I shall say to you, however, is based on years of practical experience and training. What I advise you to do are the very things I myself have found practical.

I am going to assume that I am speaking to a beginner, and the first thing I would advise him to do is to study carefully the instructions furnished with the apparatus. Learn what the regulators and gauges are for. Next I would study the adjustment of the flame. This is important because without the proper flame you cannot weld both **successfully and economically.** The proper flamegives you maximum results with the minimum **consumption of gas.** Let that point sink in. When you have your flame adjusted properly take some old scrap pieces and try your hand.

Don't be impatient to tackle your first job. You can't learn any worth-while trade in a minute or an hour. I would suggest that you start your self-instruction by practicing to weld scrap pieces of common cast iron, because it is easy to weld and because you will have many jobs of cast iron welding. I am assuming, of course, that your instruction book tells you how to hold your torch, prepare the job, etc. Next month I am going to tell you how to weld cast iron.

A. J. EMERICH.


## About American Equipment

If you are an oldtimer and have ever used our welding and cutting torches you know we build efficient tools. It's to the newcomer I would commend these remarks.

"American" torches are as good as workmanship and materials can make them. There are no better, but many inferior tools. The "American" is very economical in gas consumption and is the only non-back-firing torch on the market. The cutting torch will operate efficiently **under water,** which illustrates its adaptability. If you want to know something more about my equipment, send for our descriptive literature. I'll be glad to send it.—A. J. E.

## American Welding Co., Inc.

Cutting and Welding Torches

2724 Michigan Avenue Chicago, Illinois

## ASK ANY LARGE IRON AND STEEL CO.

**CARBO-HYDROGEN** has proven to be an exceptional cutting medium in the largest iron and steel mills in the United States.

The art of cutting not only consists in being able to sever two pieces of steel, but also to show a minimum amount of slag and unchanged metal at the edges cut and smooth surfaces after the cut is made.

**CARBO-HYDROGEN** will cut from the lightest to the heaviest metals, and by this we mean to the heaviest armor plate made, with the result that in each and every instance true cuts are made with a rapidity that is astonishing, and with marked economy.

**CARBO-HYDROGEN** burns with a clean flame and gives off no noxious fumes, and can be readily used in all confined places. It is a true combustible in every sense of the word and in nowise explosive, and, undoubtedly, is the safest gas to use.

**CARBO-HYDROGEN** is superior to use on all classes of cutting, cast iron welding, aluminum welding and brass welding. In welding, an utter absence of blowholes is noted and the welds are left soft and nice so that they can be readily machined. This is a large advantage where welds must be machined after being made.

**CARBO-EQUIPMENT** has been designed along scientific lines and no guess-work has been used in any portion of the apparatus put out.

**CARBO REGULATORS** are undoubtedly the most correct and dependable on the market.

**CARBO HOSE** will stand the greatest pressure with the longest life.

**CARBO CUTTING AND WELDING PIPES** are scientifically correct in every detail, with the theory of combustion taken care of perfectly.

## CARBO-HYDROGEN COMPANY OF AMERICA

SOLE MANUFACTURERS OF

CARBO-HYDROGEN AND CARBO EQUIPMENT

GENERAL OFFICES:

BENEDUM-TREES BUILDING

PITTSBURGH, PA.

CARBO-HYDROGEN, Reg. U. S. Pat. Off.

CARBO, Reg. U. S. Pat. Off.

# Welding Wire

APEX WALLOON

**Apex Walloon Welding Wire** will not just meet your requirements—it invariably exceeds them.

It flows at a low temperature, making a strong, homogeneous weld free from bubbles caused by lime or other impurities usually found in cheap wires.

***Send for particulars and samples***

## APEX STEEL CORPORATION

48 CHURCH ST. NEW YORK

## Canada Carbide Sales Company

30 Church Street, NEW YORK CITY

WORKS
Shawinigan Falls, Que.
Merritton, Ont.

*Sales Agents of*

## CANADIAN CARBIDE

"More gas per pound"

SIZE PKGS.
100 lb. and 1,000 lb. 25-lb. drums; 10 lb., 5 lb., 2 lb., 1 lb. tins

DISTRIBUTING STATIONS

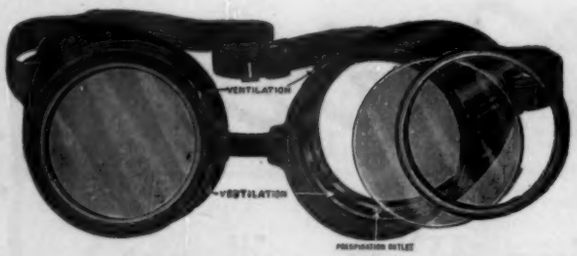
ALABAMA
Bessemer—2014-2024 Second Ave.
CALIFORNIA
Los Angeles—52nd St. and Santa Fe Ave.
San Francisco—731 Market St.
ILLINOIS
Chicago—105 W. Monroe St.
INDIANA
Terre Haute—15 No. Eighth St.
IOWA
Knoxville.
Centerville.
Albia.
LOUISIANA
New Orleans—Camp and Common Sts.
MARYLAND
Baltimore—17 So. Hanover St.
MASSACHUSETTS
Boston—47 Oliver St.
Springfield—50 Taylor St.
MICHIGAN
Detroit—343 Bellevue Ave.
MINNESOTA
Duluth—Third Ave. E. and Michigan St.
MISSOURI
Joplin—Opposite Post Office.
NEW JERSEY
Newark—See New York.
Paterson—61-63 Washington St.
NEW YORK
Buffalo—Seneca and Hamburg Sts.
Malone—32-34 W. Main St.
Middletown—23 W. Main St.
New York—30 Church St.
Troy—6 and 8 Grand St.
Trumansburg—55 Main St.
Valley Stream.
Watertown—113 Franklin St.

*Manuf'd in all standard sizes*

DISTRIBUTING STATIONS

OHIO
Toledo—Address Detroit.
Barton.
PENNSYLVANIA
Barnesboro—Ann St. and Maple Ave.
Johnstown—134 Clinton St.
Montrose.
Pittsburgh—520 Farmers Bank Bldg.
Pottsville—Centre and Market Sts.
Punxsutawney.
Scranton—339 Penn Ave.
Wilkes-Barre.
RHODE ISLAND
Providence—543 Charles St.
TENNESSEE
Knoxville—1761 Asylum Ave.
TEXAS
El Paso—22 Mills Bldg.
Fort Worth—23rd and Jones Sts.
Houston—Address Fort Worth.
UTAH
Salt Lake City—121 W. 2nd South St.
VERMONT
Burlington—Park Ave.
VIRGINIA
Richmond—1319 E. Main St.
WEST VIRGINIA
Charleston—821 Virginia St.
Clarksburg—602 Goff Bldg.
Huntington—1033 Third Ave.

***For special information address correspondence to New York City.***



# Hardy Welding

Goggles with Noviweld Lenses are in use in hundreds of factories throughout the country.

Thousands of welders are enthusiastic in their praise.

## F. A. HARDY & CO.

*JOHN H. HARDIN, Pres.*

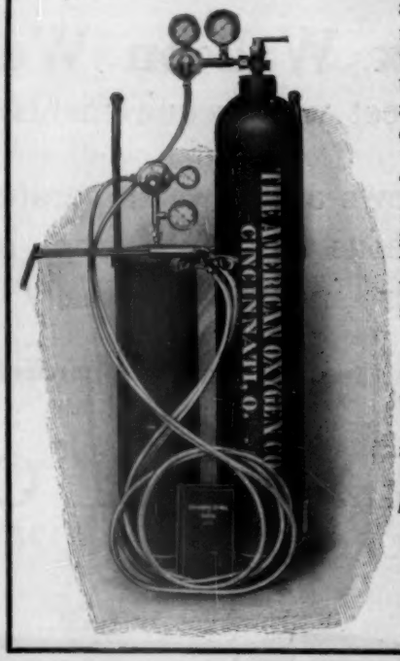
| CHICAGO | ATLANTA | DALLAS |
|---|---|---|
| 10 S. Wabash Ave. | Grant Bldg. | Praetorian Bldg. |
| NEW YORK | SAN FRANCISCO | DENVER |
| 29 E. 22nd St. | Phelan Bldg. | Gas & Electric Bldg. |

Write for Our Free Welding Goggle Book

# Pure Oxygen

Pure oxygen is essential to good work. If your oxygen supply is not up to the standard set by "American" and "Watergas" oxygen then the best welding and cutting apparatus to be had will not do your work properly.

We are glad to recommend "Vulcan" welding and cutting apparatus to our customers. No better tools are made and when used in connection with "American" and "Watergas" oxygen, with high grade acetylene, we know our customer will get results.




Write our nearest office for prices. Prompt shipments made at all times.

**American Oxygen Co.**
Cincinnati

**Indiana Oxygen Co.**
Indianapolis

# Swift Oxygen

## For Welding and Cutting

***Unsurpassed for Quality***

Pure Oxygen Electrolytically Made under the direct supervision of our Chemical Laboratory. It is carefully controlled by chemical analysis, thus insuring the highest obtainable purity.

We carry a large stock on hand so can fill orders immediately.

## Swift & Company

**Oxygen Department** **Union Stock Yards, Chicago, Ill.**

## MILBURN APPARATUS

Milburn mixing principle produces best work with minimum gas, and no flash backs, burnt tips, or other annoyances.

Exceptionally durable construction of torches insures long, satisfactory service. Regulators dependable and free from valve, diaphragm and gauge troubles.

Ask for Catalogue No. 35.

**The Alexander Milburn Company**
**Baltimore, Maryland**

**O**ur Service Plan
**X**emplifies that
**W**hen your Railroad Company
**E**njoys the use of it and a
**L**ot of Oxweld Equipment
**D**emands for power to the

**R.**ound House Foreman will

**R.**eceive no refusals

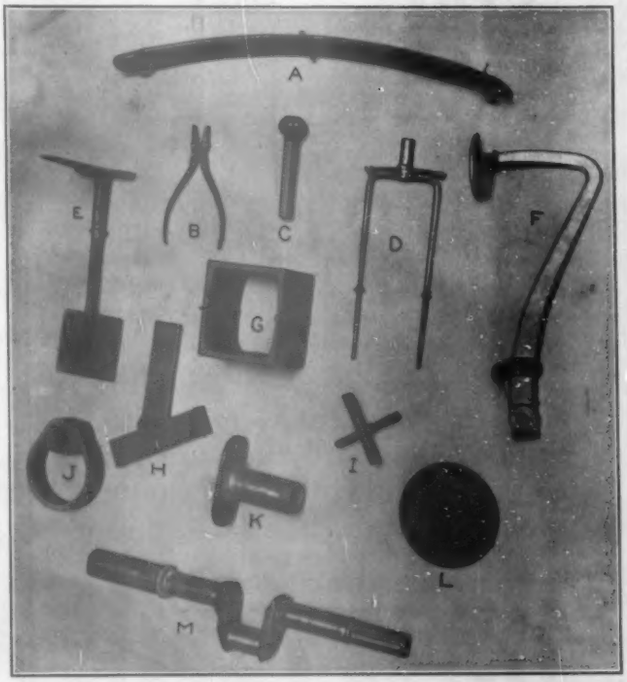
**S**imply because the Repair Force is
**E**fficient in every respect as a
**R**esult of having been instructed in
**V**irtually every known application of
**I**ncomparable Oxy-Acetylene Welding and
**C**utting Equipment, which means
**E**conomy and Efficiency.

**Oxweld Railroad Service Co.**
**Chicago New York**

*Have You Investigated*

# THOMSON

*Electric Welders?*



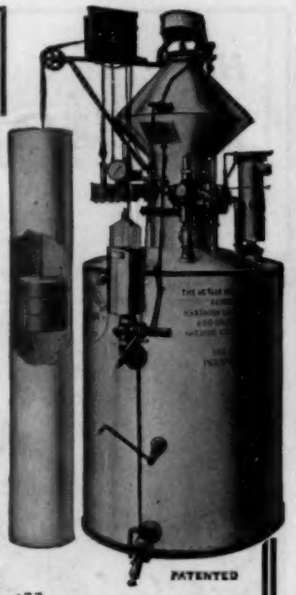

A—Spring for Auto.
B—Pliers.
C—Upset rod.
D—New ends welded on worn flyers (cotton mill mach.).
E—Auto step forging.
F—Auto foot brake.
G—Steel frame.
H—Oblique weld-steel flats.
I—Mash welded cross rods.
J—Magnet part.
K—Pipe welded to flange.
L—Solid round welded to forged flange.
M—End welded on single throw crank shaft.

**You would be surprised if you knew of the welds which are being made every day on Thomson Electric Welders. There is hardly a metal working establishment in which Thomson Electric Welders can not be employed to very good advantage. Other manufacturers are cutting down costs by the use of welding machinery, at the same time improving the output.**

**Why not prepare to reduce your manufacturing** costs by studying the possibilities right now. Describe the shape, give size of smallest and largest piece, the maximum number of welds required per day, the cost of current per kw. hour, and we will tell you what it will cost you to electric weld.

**Thomson Electric Welding Co.**
**Lynn, Mass., U. S. A.**

# Pay While You Save




The difference in cost between tank gas and gas generated in your own plant will soon pay for a generator.
This statement we are willing to back by placing a generator in your shop and allowing you to pay for it while it is saving money for you.

**METWELD**

## GENERATOR

This generator is safe for use in any plant. It is approved by The National Board of Fire Underwriters.
It is simple in operation and can be taken care of by any workman.
The tank is constructed of heavy sheet steel with every seam and fitting welded then galvanized to prevent corrosion.

***Write For Our Payment Plan***

**Metals Welding Plant**
**4401 Perkins Ave.**
**CLEVELAND : OHIO**

**Manufacturing Pipe to Sketch With the K-G Oxy-Acetylene Welding and Cutting Equipment.**

The K-G Welding and Cutting Equipment is particularly well adapted to this line of work. The range of work that can be accomplished with K-G Torches is unlimited.
Drop in and see a demonstration.

**K-G WELDING and CUTTING CO., Inc.**
***Shops and Offices at***
**556 West 34th St., New York City**

# Vulcan
## I-B Pre-heating Torch

A Portable, one-man torch, weight loaded 25 lbs.
Burns in any position. Gives a roaring flame 24 inches long, for one hour on one gallon of kerosene.

## You Need This Torch

Many a good welding job is ruined because of the lack of a first-class pre-heating torch. The Vulcan is rugged in construction, has no delicate parts and is easily operated. It is more efficient because the oil is practically gassed before burning. It does the work and does it cheaply.

***Write for Circular***

**Alger Supply Company**
**Peoples Gas Bldg., Chicago**

Universal

UNIVERSAL OXYGEN COMPANY
SHEBOYGAN, WISCONSIN, U.S.A.

PURE OXYGEN and HYDROGEN GASES
WELDING and CUTTING EQUIPMENT
Milwaukee Branch: 315 Fourth Street

WILLIS
OXY-ACETYLENE APPARATUS
WELDERS
MANUFACTURERS
of
Welding and Cutting Apparatus, Acetylene Generators, Lead Burning, Platinum Melting and Carbon Cleaning Outfits.
Gas and Oil Preheating Torches and Welding Fluxes, Rods, etc.
*Write for Catalog.*
**Henderson-Willis Welding & Cutting Co.**
2305-7-9 N. 11th St.
St. Louis, Mo.

Just Off the Press!
A New Book on AUTOMOBILE WELDING
With the OXY-ACETYLENE FLAME By M. Keith Dunham
*167 Pages* Price $1.00 *Fully Illustrated*
This is the only complete book on the "Why" and "How" of Welding

Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.
Gives principles never to be forgotten. Aluminum, cast iron, steel, copper, brass, bronze and malleable iron are fully treated, as well as a clear explanation of the proper manner to burn the carbon out of the combustion head.
Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

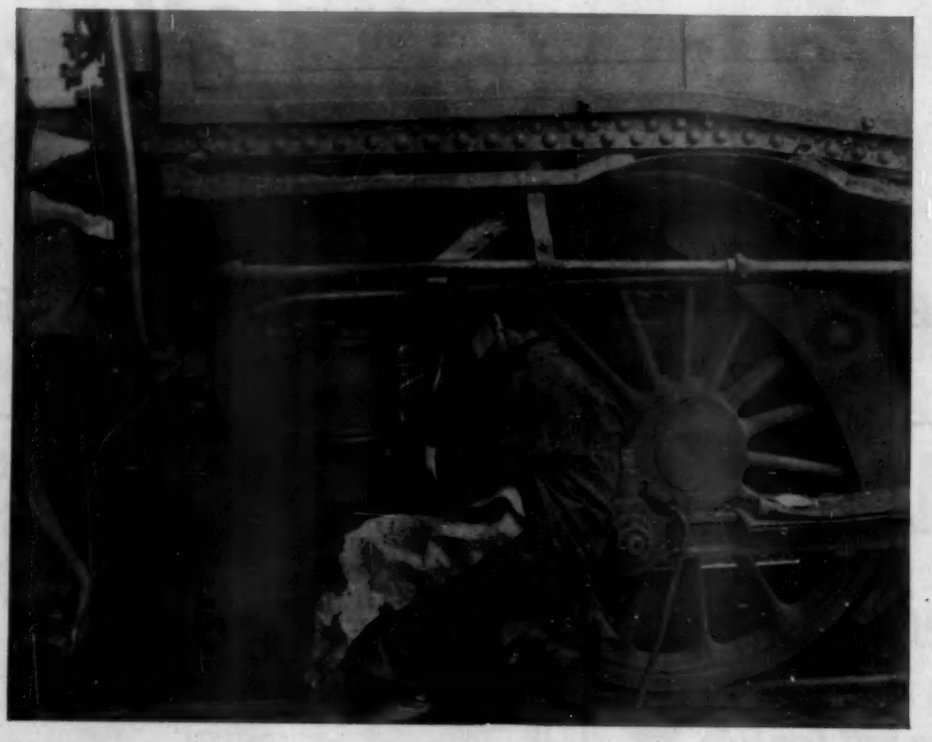
CONTENTS

CHAPTER I.—APPARATUS KNOWLEDGE.
Oxygen Supply—Care of Oxygen Cylinder—Acetylene Generation—Care of Generator—Regulators—Care of Regulator — Creeping Regulators — Gauges—Care of Gauges—Welding Torch—Care of Welding Torch—Effects of Heat—Hose and Goggles.
CHAPTER II.—SHOP EQUIPMENT AND INITIAL PROCEDURE.
Preheating Agencies—Welding Table—Location of Welding Outfit—Starting the Welding Outfit—Adjustment of Flame—Principle of Welding—General Welding Knowledge—Welding Rods and Fluxes—Choice of Tip—Expansion and Contraction.
CHAPTER III.—CAST IRON.
Simple Welding—How to Hold the Flame—Hard Cast Iron—Pin Holes and Blow Holes—Lug on Cylinder—Water Outlet—Cylinder Welding—Compression Head—Finishing and Testing—Scored Cylinders—Cylinder Parts—Fly Wheels—Pistons—Crank Cases — Babbitted Bearings — Valve Guides—Preserving Threads—Conclusion of Cast Iron.
CHAPTER IV.—ALUMINUM.
Use of—Welding Knowledge—Puddle System—Flux System—Comparison of Systems—Welding Rod—Preparation of the Weld—Inlet Manifold—Arm of Crank Case—Welding the Arm Without Taking Out the Motor—Break in the Body of Case—Welding Cold—Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case—Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Bearings—Direction of Welding—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.
CHAPTER V.—STEEL.
Welding Knowledge—What the Flame Does to Steel—The Welding Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding — Case Hardening — Light Metal Welding—Gasoline Tank—Welding Adjacent to Rivets—Shaft Welding—Construction of Parts.
CHAPTER VI.—MALLEABLE IRON, COPPER, BRASS, BRONZE.
How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.
CHAPTER VII.—CARBON BURNING AND OTHER USES OF OXYGEN AND ACETYLENE.
Principle of Carbon Burning—Method of Operation—Lead Burning—Soldering—Case Hardening—Heating Uses.
CHAPTER VIII.—HOW TO FIGURE COST OF WELDING.
Oxygen Consumption—Dissolved Acetylene Consumption—Torch Consumption Test—Acetylene Generator Consumption—Cost Card—Conclusion.

Sent to any address postpaid on receipt of $1.00 THE WELDING ENGINEER 605 So. Dearborn St. CHICAGO, ILLINOIS

Pure Oxygen and Hydrogen
Made by the Electrolytic Process
From either of our complete plants we make immediate shipments. A full stock of welding equipment is carried. It will pay you to write for prices. Our Service Department is at your service.
The Logansport Oxygen Company
Logansport, Indiana
Ohio Electrolytic Oxygen Company
Cincinnati, Ohio

Messer
Welding and Cutting Apparatus
Acetylene Generators--Pressure Regulators
MESSER & CO.
117-119-121 N. Seventh St., PHILADELPHIA, PA.



# Electric Welding Saves Locomotive Shop Nearly $8000 in Six Months

*Read this*

"The application of the electric arc welding process to the repair work in locomotive shops and engine houses is a profitable proposition for the railroad." *Report of Electric Welding Committee, Association of Railway Electrical Engineers.*

According to the above report in one month a locomotive shop saved nearly $1400 by electric welding methods and in six months nearly $8000. Four hundred and eighty-seven operations were performed in one month on 34 different kinds of jobs.

G-E Arc Welding Outfits, which assure maximum economy and convenience in this work, are in use all over the world. A constant stream of repeat orders indicate splendid operating records.

You are invited to get in touch with our nearest office for complete information.

This trade-mark the guarantee of excellence on Goods Electrical

ADDRESS NEAREST OFFICE

Atlanta, Ga.
Baltimore, Md.
Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N. C.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Columbus, Ohio
Dayton, Ohio
Denver, Colo.
Des Moines, Iowa
Duluth, Minn.
Elmira, N. Y.
Erie, Pa.
Fort Wayne, Ind.
Hartford, Conn.
Indianapolis, Ind.
Jacksonville, Fla.
Joplin, Mo.
Kansas City, Mo.
Knoxville, Tenn.
Los Angeles, Cal.
Louisville, Ky.
Memphis, Tenn.
Milwaukee, Wis.
Minneapolis, Minn.
Nashville, Tenn.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Niagara Falls, N. Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
Providence, R. I.
Richmond, Va.
Rochester, N. Y.
St. Louis, Mo.
Salt Lake City, Utah
San Francisco, Cal.
Schenectady, N.Y.
Seattle, Wash.
Spokane, Wash.
Springfield, Mass.
Syracuse, N. Y.
Toledo, Ohio
Washington, D. C.
Youngstown, Ohio

For Michigan business refer to General Electric Company of Michigan, Detroit, Mich.

For Texas, Oklahoma and Arizona business refer to Southwest General Electric Company (formerly Hobson Electric Co.), Dallas, El Paso, Houston and Oklahoma City.

For Canadian business refer to Canadian General Electric Company, Ltd., Toronto, Ont.

General Foreign Sales Offices, Schenectady, N. Y.; 30 Church St., New York City; 83 Cannon St., London, E. C., England.

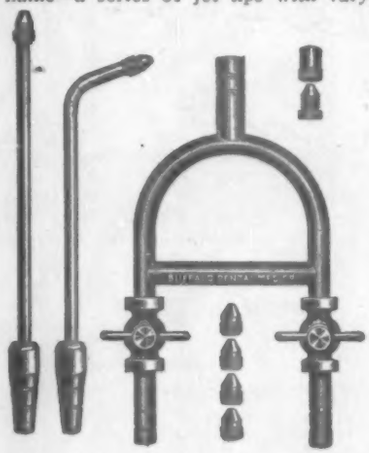
# General Electric Company

General Office: Schenectady, N. Y.

6862

# FOR LEAD BURNING

Our No. 28 Oxy-Hydrogen Lead Burner is most complete. Equipped with taps that are ground to a seat, making them easy to manipulate—safety gauzes in the throat of the yoke to prevent accident by a flashing back of flame—a series of jet tips with varying sized



orifices, and a wind shield adjustment to permit its use in draughty places. A straight and curved burner shaft that will meet every possible condition. Price, complete with 5 feet rubber connecting tubing, $7.00. Ask for catalog "B. X.," illustrating and describing this and all our chemical laboratory apparatus.

**Buffalo Dental Mfg. Company**
**Buffalo, N. Y., U. S. A.**

# Whatever Your Standard May Be the VULCAN Will Square Up With It

If it's completeness you want in an oxy-acetylene welding outfit—you'll find in the vulcan everything you want or need for any job.

If it's the efficiency—the hotness of the flame—the Vulcan will claim your more serious consideration after any comparative test you care to make.

If economy of fuel consumption means anything to you — then the name "Vulcan" does also.

Write for catalog W-1.

**VULCAN PROCESS COMPANY**
**2445 University Av. South East**
**Minneapolis - Minn.**

# Oxy-Acetylene Welding

**A Comprehensive Treatise on the Practice of Welding Cast Iron, Malleable Iron, Steel, Copper, Brass, Bronze, and Aluminum by the Oxy-Acetylene Method, together with concise information on the Equipment required for both Welding and Cutting by this Process**

**By S. W. MILLER**

**287 Pages, 6 x 9 Inches, 192 Illustrations**

**PRICE $2.50**

Ten years ago the oxy-acetylene method of welding and cutting metals was hardly more than a laboratory process, but in the course of these few years it has become one of the most important of the methods in the metal-working industries. Much has been published relating to this process, but a great deal of that which has been placed on record in the past has been descriptive of odd jobs. It is, therefore, believed that the present volume, dealing in a more systematic manner with the principles and practice of the art of oxy-acetylene welding, will be of considerable value to those engaged in the metal trades.

The information here presented on the subjects of oxy-acetylene welding and cutting has been mainly furnished by S. W. Miller, proprietor of the Rochester Welding Works, whose wide experience in the practical application of the process, and whose success in the work, vouch for the reliability of the information here placed on record. The experience of the author in the oxy-acetylene welding field has been unusually extensive, but having been mostly on repair work, he has written especially for those engaged in a similar line. A great deal of the work done with the oxy-acetylene welding torch is on repairs, and while there are also a great many applications of it in manufacturing work, such applications are more or less special in each case, and sometimes require a great deal of experimenting before success is attained. The general principles here presented, however, apply equally to repair and manufacturing work. This volume describes the equipment required for oxy-acetylene welding and cutting, deals in detail with methods used in welding cast iron, malleable iron, steel, copper, brass, bronze, and aluminum and gives in addition, special attention to the welding of sheet metal, tank welding, boiler repairs, etc., as well as to the subject of lead burning, which is a special kind of autogenous welding.

The book contains twelve chapters headed as follows:

Equipment for Oxy-acetylene Welding.
Preparation of Work for Welding.
Materials and Fluxes used for Welding.
Making Oxy-acetylene Welds.
Oxy-acetylene Welding of Cast Iron.
Welding Steel, Malleable Iron, Copper and Copper Alloys.
Welding Aluminum
Sheet Metal, Boiler, Pipe, and Tube Welding.
Oxy-acetylene Welding of Tanks and Retorts.
General Considerations in Oxy-acetylene Welding.
Lead Burning.
Cutting Metals with the Oxidizing Flame.

**For Sale By**

**THE WELDING ENGINEER**
**608 South Dearborn Street Chicago**

# Finding the idea you want—*Quickly!*

If you can't use an idea in THE WELDING ENGINEER in January, perhaps it will repay you many times the subscription price next July.

Yet when you *can* use that idea, are you always able to find the article *immediately*—or do you have to rummage for it in forgotten places, often to find that it is lost? Keeping your back copies in a *usable* form is only one of the advantages of

**THE WELDING ENGINEER**

If your associate *must* borrow your WELDING ENGINEER, hand it to him in a binder; he can't forget to return it. Again, this new binder will keep your copies free from dust and germs—with no torn and mutilated pages.

With this Binder you can convert your pile of magazines into a valuable ready-reference business library—you have at your finger-tips the actual knacks, the methods *proved* by the experiences of other welders.

Each "Arnold" binder, made especially for us, has a capacity of 12 issues—nearly 500 pages of ideas and suggestions from the "other man." Bound in the latest scratch-proof, dirt-defying, reverse green Buckram cloth; solid metal back. To insert magazine, merely place one of the rods between any two pages and slip it over the binding posts—no ripping or cutting necessary. Neatly stamped with THE WELDING ENGINEER logotype.

Better send for your Binder TODAY—before *this* important issue is mislaid. Furnished AT COST — Price, $1.00. *Two copies*, $1.75.

**THE WELDING ENGINEER, 608 S. Dearborn St., CHICAGO**

**Abnormal Business Conditions—**
**What We Are Doing to Meet Them**

**Chapter I**

## Helping the Manufacturer to Improve and Perfect the Oxygen Cylinder

Linde engineers are to be credited with the development of the oxygen cylinder now in world-wide use.

Co-operating with cylinder manufacturers, our engineers have developed a special treatment for cylinder steel that has improved the quality and reduced the weight of the cylinder steel approximately 30 to 40%.

**This material reduction in weight has brought about a corresponding reduction in shipping and handling charges all along the line—a reduction that has saved oxygen users tens of thousands of dollars a month.**

This special process treatment for cylinder steel insures absolute uniformity of structure—analysis—and essential physical characteristics.

In connection with this work Linde engineers have also given a great deal of time and study to the improvement and development of special cylinder valves, of cylinder paint and of other features that work for the life of the cylinder and the safety and economy of oxy-acetylene processes.

The brilliant success of our engineers in this field has been recognized by many large steel concerns, who have pronounced the work worthy of high rank in the technique of steel manufacture.

Chapter "J", the next of this series, will tell of the work of a branch of Linde engineering in connection with the testing of steel, valves, gas, etc., and work that involves over six million operations per year.

**The Linde Air Products Company**
**42nd Street Building, New York City, N. Y.**
*"Largest Producers of Oxygen in the World"*

# ELECTRIC SPOT WELDING

*Some of the Interesting Uses to Which Spot Welders Are Being Put— Our Old Friend, the Rivet, Has Been Chased off the Map*

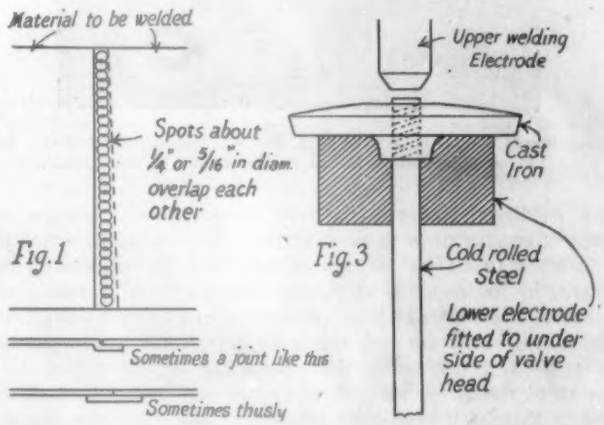
*By* Albert E. Hackett

TO the careful observer of manufacturing methods, the one thing most evident is the fact that we, as a producing nation, are constantly changing our methods of manufacturing. The processes of yesterday are discarded and forgotten for the new discovery or improvement of today. We are living in an age that demands of all means of production the highest degree of efficiency, and whether the manufacturer of any particular article depends on the human or on the mechanical elements in this plant, he quickly realizes that any method or process that tends to increase his output means a proportionate increase in dividends. It naturally follows, therefore, that he is keenly on the alert for new ideas, which he usually is eager to consider in his business. Many a manufacturer has in the nick of time been enabled to make a slight cut in production costs by eliminating a simple operation here or there, thus reducing the price of some particular part of an article, thereby placing himself on a sound basis, in spite of the fact that he had struck the toboggan of financial ruin and was rapidly nearing destruction.

Competition is this factor that produces the new and improved method, resulting in either a reduced cost or a superior article, and in more instances than not, costs and quality are both affected, to the decided advantage of the manufacturer. The truth of the old adage that "Neccessity is the mother of invention" was never more apparent than at present, when the desire for bigger and better things is nation wide.

Were we asked to name some particular element that has in the past exerted some great or wide felt influence in our industrial career, giving us a boost toward the success we have since achieved in every line of endeavor, some would venture one thing and some another. Personally, however, the writer is strongly of the opinion that we are endebted to nothing else, in so great a degree, as we are to that mighty force "electricity," the most wonderful and versatile of all the means by which man has been privileged to better his condition in life, to the end that he might enjoy more of the advantages that have been placed within his reach. What electricity will not, or has not, accomplished could much more easily be described than the things it can and has been made to do. It drives the wheels of industry in our shops, it moves their product from place to place; the traffic of our street railway systems is transported by its aid; it illuminates our streets, our stores and our homes. The physician prescribes and administers it under certain conditions to prolong life and the law steps in and administers it to snuff out the life of whom it wishes to destroy. A few short years ago, a fascinating subject for simple experiments, for those with a scientific turn of mind—today, a mighty force obeying the slightest wish of man whose servant it is.

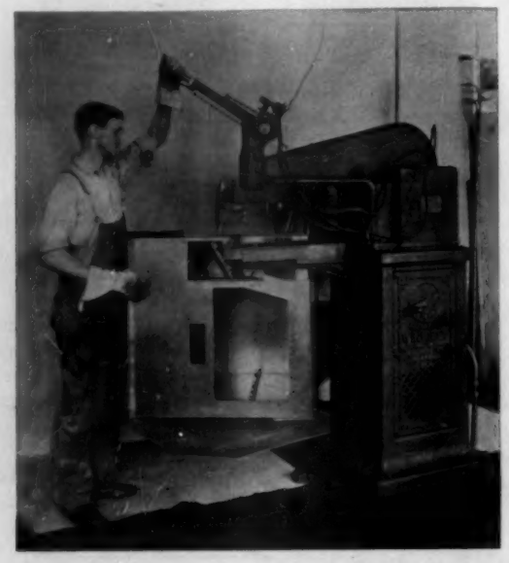
Of all the uses to which the electric current has been put in late years, none perhaps is more interesting or more important, from a strictly manufacturing point of view, than that of electric welding, both by the well known butt welding process and that other, more recent adoption, spot welding. The mere mention of welding, naturally, brings to mind that familiar sight in every hamlet in the land, "The Village Blacksmith," and with this vision comes the blacksmith's shop with all of its grime and dirt, and the merry ring of the anvil, as the smithy pounds and hammers the work he has in hand. It is explained that none of these conditions accompany the installation of an electric welder, designed for either process of welding, that all the work is done by means of the electric current. It is then that visions of mighty cables to conduct the current, instruments of


Material to be welded
Spots about 1/4" or 5/16" in diam. overlap each other
Fig.1
Sometimes a joint like this
Sometimes thusly
Upper welding Electrode
Cast Iron
Fig.3
Cold rolled Steel
Lower electrode fitted to under side of valve head

various kinds, switches and myriads of intricate and delicate apparatus loom up in the mind of the interested listener. Keenly disappointed when the welding operation has been observed, for he was fully prepared to witness a pyrotechnic display that would have done credit to an inferno, he seeks a more detailed explanation of the phenomenon he has been privileged to witness and soon learns that the electric current is made to do its work silently and swiftly, with apparently no more effort than we exert in sipping our coffee at the breakfast table. Small wonder, then, it is, that such a simple and effective method should have so quickly come into almost universal favor.

Since the purpose of this article has for its object a brief discussion of electric spot welding as applied to manufacturing, a brief discription of the process and some of the requirements for its successful employment will not be out of place at this point. A welding outfit consists primarily of a suitable apparatus to transform the line voltage ordinarily available to a predetermined voltage suitable for each particular class of work, means for applying the current to the aforesaid work and a switch for controlling the same. Other features, of course, enter into the design of apparatus of this kind; but the ones just mentioned cover the essential parts necessary to be mentioned herein. By means of the transformer, we may reduce our line, or primary voltage, of say 220 volts to a secondary voltage of

from 2 to 6, this transformation, as any student of electricity understands, means a corresponding increase in amperage, which produces the heat for welding when properly applied. Such an enormous flow of current at a comparative low pressure, necessitates large conductors for carrying it without loss or danger of the machine becoming heated, which fact accounts for the large amount of copper one generally sees on any well designed electric welder. The theory of



**Steel Range Bodies Are Now Spot Welded, Instead of Riveted. Improved Construction Means Better Results in the Article.**

the welding process is that the current flows through the copper conductor with comparative freedom, until it reaches the work to be welded, which has been placed in its path, when, in its struggle to continue, owing to the greater resistance the material being welded offers to its passage, intense heat is generated, when at the proper time pressure is applied which forces the metals together, resulting in a union of the two pieces, that is as strong as any part of the pieces that have been thus joined. A feature of the electric process that is the direct opposite of any other process of welding, is that the heat is generated at the center of the material being welded, or at the point of contact, generally speaking, of the pieces, which is a condition that makes certain the proper union of the two, for by the time the outer surface has become heated and the pressure applied, a perfect weld is sure to result.

While it would be extremely difficult, if at all possible, to enumerate all the lines of manufacture that have adopted, in some form or other, the process of electric butt, jump, flash or spot welding, a few lines can be given at least sufficient attention to demonstrate the success which has followed its introduction. The automobile industry has, perhaps, been most active in the adoption of spot welding apparatus in the preparation of the various parts that enter into the automobile of today. The one important fact and perhaps next only to that of economy, is that when two pieces of metal are joined by spot welding, the joint is invisible and the closest investigation cannot determine its location after the parts have been finished by the painter. Compare this one feature with the old-fashioned rivet head, which cannot be concealed, and no argument for the old way can be advanced. The body of the low and medium priced automobile is made up of several sheets of steel that have been formed up in large hydraulic presses. These parts are then taken to the electric welder, which is generally of a type driven by an electric motor and designed to operate continuously as long as the operator depresses a release treadle, the work then being fed through the machine making a series of spots, each overlapping the other as indicated in Fig 1; a continuous weld is thus produced, which when ground or filed slightly, cannot be detected and a union that cannot be separated short of the entire destruction of the article. It is claimed by manufacturers who have adopted this method of welding, that it can be done more quickly and with less expense in this way than in any other, with better satisfaction. Two or three parts thus assembled are then reinforced and braced to make the body rigid and firm, without the use of a single rivet, unless in some inaccessible place where it would not be possible to introduce the electrodes of the spot welder. The body, however, is designed for welding and special welders are built for these particular places, so it might be said that the spot welded auto body is now in almost universal use. The same is true of the fenders, windshield, hood, radiator frames, oil pans, instrument boards, tool boxes and many other parts and articles too numerous to mention. A new use to which the butt welder has been put in the manufacture of windshields, is to take two pieces of tubing that have been cut off square on a band saw, place them in the welder and apply the current, the surplus metal being quickly burned away, until a perfect miter weld is produced, considerable cutting and fitting being eliminated by this method, making a very great reduction in the total cost of the finished piece. The spot welder as applied to the automobile industry has long since passed the experimental stage and is now accepted as an absolute necessity by the up-to-date manufacturer. Its use means much in the building of all the medium priced cars, because of its economy both in labor and material. We have in mind a large automobile factory in the city of Detroit, said to be the largest of its kind in the world, where more than fifty welders of one make are being used every day Other instances of a similar nature could be cited.

A few years ago, there was erected in the city of Chicago

**This Cut Illustrates a Motor Driven Spot Welder, Installed in an Automobile Body Factory, and Is Being Used to Make the Weld as Shown in Figure 1.**

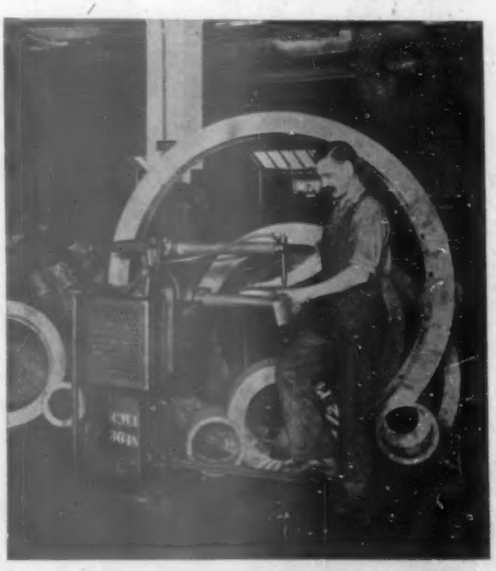
the first building in which the so-called "steel skeleton" type of construction was used. This was a decided improvement and a radical departure from the old-time wall of solid masonary which limited the height to which a building could be erected to a few stories only. With the new type of construction, the height of buildings rapidly increased, until

some cities were obliged to place restrictions on the number of floors to which they could be built. To reduce the fire hazard in such buildings, the manufacturer of office furniture turned his attention to the use of steel fixtures which in themselves would be proof against destruction by fire, it being a well known fact that a structure, which in itself might be fireproof, could be seriously damaged, if not completely destroyed, by the contents themselves. The manufacturer of metal specialties followed the furniture people and there was shortly introduced a line of fireproof metal doors and windows, interior trim and nearly everything else required in the equipment of modern office building. Many of these articles, in the early days, were either riveted or brazed; today the electric spot welder is used to as good advantage as in any other sheet metal line. A door or piece of furniture might be finished to represent the grain of some beautiful wood; but if it had a rivet here and there on its surface its appearance would not only be marred, but it would be proven a sham. Thus the spot welder plays an important role in a field that has within a few years exerted a wonderful influence on our building industry. A concrete example of the saving which follows its use in connection with steel door work may be cited, where, in the western part of New York State, a certain manufacturer was able to transfer to other work twelve men who had been riveting and soldering, the same amount of work being done by one man and a boy using an electric spot welder. It might truthfully be said that the development of steel furniture and interior trim of every description was largely influenced by the process of electric welding, and manufacturers of these articles, in their advertising matter, call particular attention to the fact that the work is not riveted but "electric spot welded."

While the advantage of electric spot welding in ordinary work, that could be riveted without difficulty, has never

**A Typical Automobile Factory Installation. This Particular Machine Is Being Used for Welding Fenders, Cowls, Hoods, Etc.**

yet been questioned, it has been demonstrated time and again that it is particularly well adapted to work that is of such a nature as would make riveting extremely difficult if not impossible. The welder illustrated in Fig. 2 shows a specially designed machine arranged to operate with a dial feed, to automatically weld a caster holder for metal beds. The stem which is welded to a flat band is formed up from a flat sheet, into the shape of a tube and one end slit and bent over to close that end; it can readily be seen that to rivet such a piece, would prove very impractical, inasmuch as there would be little or no surface for the rivet to hold to, since the construction of the stem would not provide a full hole in any single thickness, with sufficient material surrounding it to provide the necessary strength to insure a satisfactory job. The possibilities of spot welding were



**This Machine Is Used in the Manufacture of Gear Guards, for Machinery of All Kinds, No Rivets Being Used at All.**

investigated with the result that this machine was built for this particular job. Its operation is automatic and simple in the extreme, it only being required of the young lady operator, that she keep a small treadle depressed with her foot which permits the motor to keep the machine in continuous operation, and place on the spindle of the dial a holder which is then carried under the welding point, where it is welded and later removed and a new one put in its place. An examination of one of the holders thus welded will show that the condition which makes riveting difficult renders welding ideal, in that the pieces folded over being to a certain extent uneven, offers increased resistance to the passage of the current which causes them to heat quickly when the application of pressure forces the whole into a homogeneous mass, making it possible to entirely destroy the usefulness of the article before causing the weld to part. An idea of the speed, with which such work can be accomplished may be gained when we are informed that one girl with such an outfit can easily weld from 25,000 to 30,000 pieces in a day of ten hours. It is a significant fact also that the cost for current for work such as this is negligible, the consumption not exceeding over 1½ or 2 kilowatts for 1,000 welds. The current for welding and for operating a ½-horsepower motor with which this machine is equipped is therefore the only expenditure required except the wages of the operator, making such a machine a very satisfactory investment from a financial point of view. This is only one of many examples of the adaptation of spot welding to difficult operations. Another interesting use to which the process has been applied is that of welding the stem into a cast iron valve disc as shown in Fig. 3. This construction is applied to several popular priced automobiles, one Detroit firm having no less than five machines designed for this one operation and nothing else, the disc is drilled and tapped and the stem screwed into place, when it is placed in the welder, current applied until the iron and

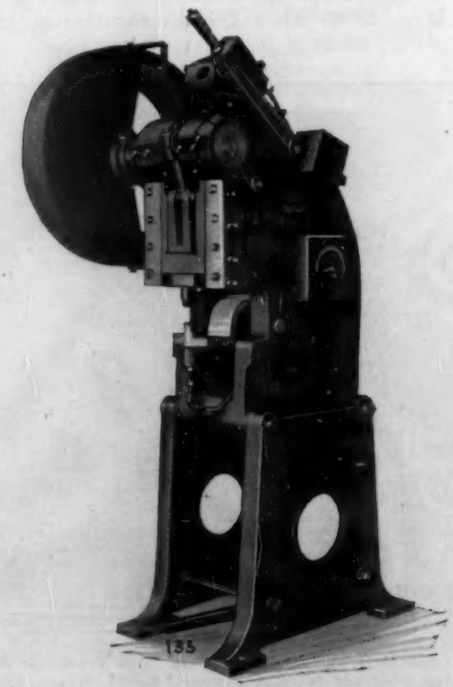
steel are properly heated, when they are forced together by the application of pressure. Another type of valve that is meeting with considerable favor, in which the process of electric welding is employed, is one that is made up of alloy steel, the head being turned from the solid stock with a small projection left for welding to a small rod of ordinary CRS stock. This is a strictly butt welding job, however, and is simply mentioned to show the possibilities in this connection. Numerous articles, such as shafts, spindles, etc., which

**A Spot Welder Equipped with Dial Feed. A Most Efficient Machine for Welding Duplicate Parts in Large Quantities.**

are now being turned from solid stock with excessive waste can be successfully butt welded, effecting very large savings in both time and material consumed. It is also possible under certain conditions to electrically heat and upset in the butt welder rods of various diameters which can be used for small gear blanks, shafts, etc. For such work, the butt welder is particularly well adapted, although in some cases a spot welder is employed.

A careful examination of the watch that is said to have "made the dollar famous," would not indicate that an electric welder had been used in its construction, although such is the case. The fact that brass, German silver and similar metals are used, would make it difficult, if not impractical, to weld any part of the watch, even if welding of any part of it were advisable. The operation, however, in which the welder has been employed with the best of satisfaction is in securing the pendant to the ring—riveting was not the ideal method of doing this job, and soldering in the ordinary way was not easy. Some experiments with the use of a specially designed spot welder, with a jig to hold the pendant demonstrated its success beyond all question, its operation being simple and rapid. The pendant being clamped in the jig, the ring is placed in position on it and a small bit of solder dropped in place; the electrodes are then brought in contact, when the application of the current causes the solder to instantly melt and flow into place, making a perfectly tight and secure job. The field for such work is limited, however, to a small line of articles, such as watches, optical goods, cameras, etc., where the work is of a delicate or complicated nature. The possibilities, however, are readily apparent to one who is interested in such matter and doubtless other work will be done where it can be employed to advantage.

The improvements that have been effected in late years in the making of high-grade tool steel, together with the heavy demands the war in Europe has made on our steel plants, has caused the price of this commodity to reach such a point as to almost prohibit its use in the machine shop. On the other hand its use cannot possibly be dispensed with, owing to the keen competition and the demands for efficiency that exist in nearly every line of business. It, therefore, became apparent sometime ago that any process that would enable the machinist to use a smaller quantity of this high-priced material would be equivalent to a great reduction in the cost of the same. The matter was brought to the attention of a prominent manufacturer of electric welding machines and a machine was designed to electrically weld small pieces of high-speed tool steel to shanks of ordinary CRS stock, which was installed in the plant of a well known Detroit builder of high-grade autos. The scheme met with such marked success that it was soon taken up in every locality until today its use is almost universal. In actual practice a small piece of this expensive tool steel is fitted to a shank of common CRS stock and welded either in the spot welder or in some instances in a butt welder, under very similar conditions to any other electric welding operation. After the two pieces have been welded, the tool is either annealed and afterward ground to the shape desired and then hardened by any one of the several methods employed for that purpose, or it is taken from the welder and hardened in an oil bath, or by some other one of the many processes, and shaped for the purpose for which it is to be used and put into service. The tool made in this manner will do just as effective work as though it were

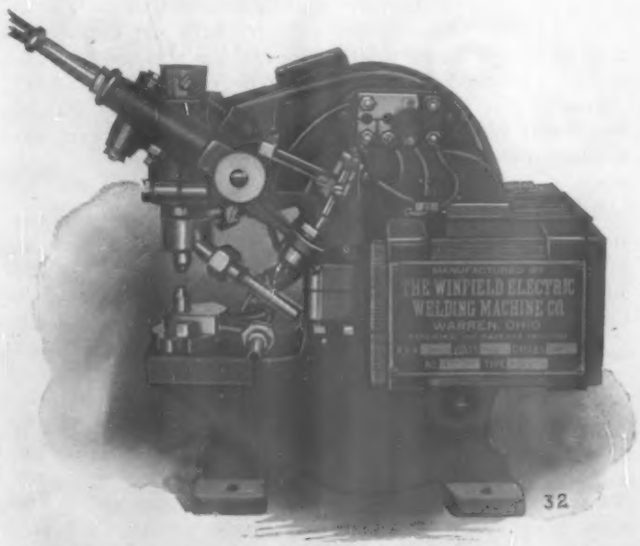


**An Electric Riveter—No Dirt—No Noise—No Danger.**

made of a solid piece of tool steel, at an immense saving in cost. The manufacturer in Detroit, who was without a doubt the first to install an electric spot welder for this purpose, reports that all cast-off tools of high-speed steel that were about to be sold for junk, were gathered up and forged into thin strips. These were later cut into small

pieces and welded to ordinary steel shanks, effecting a saving almost sufficient to pay for the entire cost of the electric welder equipment. Such instances, though perhaps not common, illustrate what the up-to-date factory manager is doing. The old adage that "A dollar saved is a dollar made," was never more true. The machine shop that has not a sufficient volume of such work to justify the purchase of a machine, can usually find a spot welder in his neighborhood where it can be done for a very nominal charge. While a spot welder is very practical for welding lathe, planer, shaper and other tools of a similar nature, the same work can be accomplished in some cases to a little better advantage in a butt welder; in addition to this it is possible, in the latter type, to weld drills, reamers, broaches and many other tools that could not be done in the former type of machine. This account for the installation of many butt welders in machine shops for tool welding, inasmuch as any type of tool can be welded by its use.

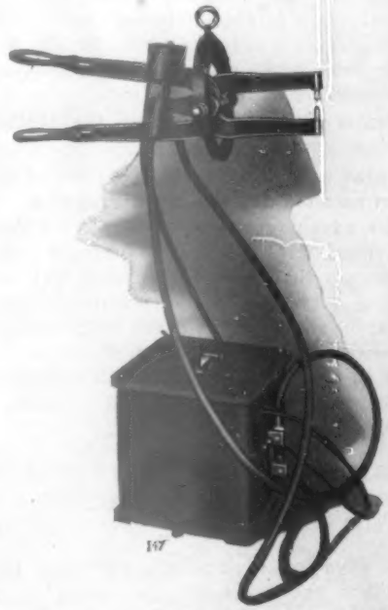
The machine illustrated in Fig. 4 was the result of a request for a more efficient method from the manufacturer of an article which necessitated the employment of one of the very expensive metals, a very small saving on each one of which would annually total a very large sum. It is generally understood that platinum is perhaps the best material known of, for the contacts on electrical apparatus, where it is required to make and break the circuit. The vibrator on a spark coil, therefore, is provided with a platinum contact. This contact was one made in the shape of a rivet which was secured to the spring steel vibator by inserting the rivet in a hole provided for it, and then riveting it over. It was desired to reduce the amount of material contained in the rivet, if at all possible. That was the first problem; the next was to reduce the cost of assembling the two parts. Several methods were tried with results that were not at all satisfactory; then electric welding was tried out with the results that proved more than satisfactory. In place of the rivet, a very thin disc of platinum was prepared and, with the spring steel vibrator




**This Is the Machine Used for Welding the Platinum Disc on the Spark Coil Vibrator. They Save Their Cost Several Times Each Year.**

without the hole having been punched in, was placed in the electric welder and despite the fact that the steel was of a rather high carbon content, the weld was pronounced perfect. The old method with its consequent waste of both time and material has been abandoned by the progressive factory manager and the new method substituted for it One manufacturer reports that he is saving several thousands of dollars' worth of platinum every year in its use.

The spot welder is also used very extensively by manufacturers of articles which, of necessity, must be riveted;




**A Small Portable Welder for Work That Cannot Be Taken to the Machine. Take the Machine to It.**

for instance when it is required to rivet a casting to a sheet steel stamping, they cannot be welded together, but it makes an ideal job for electric riveting. In place of the upper and lower welding electrodes, a die, which is cupped to conform to the shape of the rivet head, is substituted. The pieces to be riveted, with the rivet in place, are put in the machine with the rivet head in the lower die. The application of the current quickly heats the rivet when the pressure of hand lever or foot treadle forces it down and forms the head in one simple operation. The advantages of this method are many; there is, first of all, absolutely no noise connected with its operation, this item perhaps being of most importance, for who is it that enjoys the incessant racket and roar of the air riveter? Then there is no forge fire with its heat and dirt; this can only be appreciated by those who, on a hot day, have been compelled to work in the heat and grime that goes with the job of heating rivets. The banishment of noise, heat and dirt will work wonders in improving the conditions under which men toil; and the electric riveter is making wonderful strides in this direction.

And so it goes; one might name one thing after another, and continue indefinitely, naming and describing this, that or the other operation that is being done silently, rapidly and economically by the electric spot welding process. New uses are found, every day, to which it can be put and while electric welding, either spot or butt, is not the panacea for all the ills and aches and pains that the manufacturer experiences from time to time, still it has proven itself to be the antidote for many of them and few decline to take the medicine that the electric welding engineer prescribes after he has had sufficient opportunity to make a study of the case and render a diagnosis of it.

The sum total of the advantages of electric spot welding might be described as follows: It is extremely rapid in operation, due to the fact that it heats at the point of contact only. It is economical in time and current consump-

tion for the same reason that it is rapid. It is not necessary to be a skilled mechanic to do highly successful work. It is positive in its operation, it is noiseless and it is clean. The apparatus is compact, requiring very little floor space for its accommodation, which is a very important item in the majority of cases. Another item of equal importance is the fact that there is absolutely no danger connected with its operation. This is contrary to the popular idea, that danger always accompanies the use of any electrical apparatus. It is nevertheless true, since the welding voltage employed is little greater if any than that of the ordinary dry battery that rings your door bell.

Electric spot welding was little appreciated at first, being looked upon as a fad and the production of a crank. When, however, its advantages were realized, the demand for i became universal, until today, as has already been mentioned, few lines remain that have not in some way found use for it. Even so, it seems that the surface of its possibilities has only been slightly scratched, and we freely predict that still newer and more wonderful things yet remain to be done by it, than have yet been accomplished. Who can say what they will be? The future alone holds the answer.

## BUTT-WELDING ATTACHMENTS FOR ELECTRIC SPOT WELDERS.

In these days of high-priced materials manufacturers whose products are made of sheet and bar-stock metals find it profitable to utilize much of the scrap stock that was formerly discarded. Some have redesigned a part of their product to enable them to utilize scrap pieces of metal. I know of one instance where new goods that could be made of the sheet-metal scrap from the press department were added to a manufacturer's line.

In steel switch-box manufacture one concern has placed on the market a small steel box formerly made of two pieces, which is now made by spot welding together four pieces that were formerly scrap. This is real economy in this case, as the increased cost of sheet steel greatly offsets the extra labor required.

We use a great deal of ⅜-inch round mild steel, which is cut up into different lengths ranging from 6 to 18 feet and threaded on the ends to be used as tie rods for supporting street-lighting fixtures. These rods are purchased in long lengths from the steel mill; and although we find it more profitable to cut them to size, as 6 feet is the shortest length we can use, the scrap loss is quite an item.

### Unsuccessful Attempts to Dispose of the Material.

We tried to dispose of this material by offering it to bolt manufacturers, but were unsuccessful, for they require undersize rods, owing to rolling most of their threads. It was then decided to butt weld these short rods into usable lengths, if it were possible to do so on our electric spot-welding machines.

This decision led to the design of a butt-welding attachment. An attachment of this kind will readily convert an electric spot welder into a butt welder and will be found profitable by concerns doing spot welding and occasionally butt welding, but not in quantities sufficient to warrant the expenditure for a butt-welding machines. However, when the rods to be welded are long, more work can be welded with a butt-welding machine, as the work on a butt welder is held horizontally and can therefore be handled more conveniently.

This attachment will also butt weld high-speed steel tips on carbon-steel shanks. By butt welding the round shanks of worn-out high-speed drills to carbon-steel rods the tool maker can make many cutting tools that would otherwise be quite expensive.—*By A. J. Chamberlain, in American Machinist.*

## VALUABLE WELDING REPAIR.

The cellar for a new building on Twenty-second Street, New York, was recently excavated by a large Thew steam shovel, after which the shovel was raised up on cribwork to the street level to remove it. After being jacked nearly to the full height the steam shovel fell to the bottom of the excavation and was badly wrecked, many of the pieces being so much broken and twisted that it was necessary to take the shovel to pieces and practically rebuild it.

Instead of sending the damaged parts back to the manufacturer to be repaired or replacing them by new pieces which would have occasioned a considerable delay, for ordering and receiving them, they were taken to the shop of the K-G Welding and Cutting Co., Inc., New York, where they were so quickly repaired and returned that the shovel was put in order and ready for work again within one week after the accident, thus saving a considerable amount of time that would have been necessary for factory repairs, besides saving the cost of new pieces which would have been much greater than the cost of mending the old ones. —Contracting.

## WATER IN CYLINDERS.

Editor—We have had a number of oxygen cylinders lately which contained considerable water. Will you let me know the cause of this? The oxygen is made by liquid air process. Also tell me if this is likely to cause trouble in welding.

James D. Small.

Answer: Water in the cylinder is a problem manufacturers have to contend with, particularly in the winter time. It apparently is not always possible to at all times prevent its getting into the cylinder and when it does, the welder should remove it. This you can do by tipping the cylinder upside down and opening the valve slightly until the water is forced out. You can probably more conveniently get the cylinder into an upside down position by making a clamp to attach to the wall to hold the cylinder or of making a shelf a couple of feet from the floor and "notching" it so that this notch will hold the cylinder while the valve and neck slips through it and you are enabled to open the valve from underneath the shelf.

Water coming through to the welding torch may be considered harmful to a weld. In addition it badly affects the proper working of the regulator, helps to destroy the hose and does not do any good at least to the interior of the torch.—Editor.

## AUTO SHOP WELDING KINK.

A writer in the *Automobile Trade Journal* suggests the following for the automobile repair shop:

Most repair shops will have a ⅜-in. brace wrench with the socket end worn out. Using this, together with a Ford spark plug wrench, it is an easy matter to make a 7-16-in. brace wrench. Saw the socket end of the wrench off. Saw the socket end of the plug wrench off. (This will not spoil it as a plug wrench.) Then have an acetylene welder, to weld the 7-16-in. socket to the brace wrench, at a cost of $ .25, and you have a brace wrench for cylinder head cap screws that will clear both radiator and dash and allow of a free swing.

A 7-16-in. Mossberg socket can be used instead of the socket end of the spark plug wrench.

# WELDING *and* CUTTING *with* OXYGEN *and* ACETYLENE

## *How and When to Weld — The First of a Series of Practical Articles*

*By* M. Keith Dunham

*FOREWORD.*

*Following is the first of a series of articles on welding and cutting with oxygen and acetylene. Properly, perhaps, a portion should be devoted to gases used, principles of regulators and torches, etc., but this would mean space which in a trades paper may be considered too valuable. Hence the series starts without this premilinary work and the first subject is "Metal Knowledge."*

*This does not mean that the author considers the subject of apparatus (or gases) an unimportant one. On the contrary it is of the utmost importance and this series on welding and cutting, while not mentioning apparatus, is written with the hope that readers are already equipped with a proper outfit, or if they are not that they will secure one.*

*Good or economical welding or cutting is out of the question without a good apparatus and while reading alone will not make a welder, reading will help the welder or prospective welder to avoid what I might term fundamental mistakes, providing his apparatus, gas and supplies are correct.*

*If the readers will pardon me I want to at this time say just a personal word. The series will in no way be technical. Without decrying the value of technical matter, I believe the great need of the industry is simple text, explaining principles rather than details, trying to drive home the reason WHY as well as show HOW. While the idea is to help the beginner or student, it might not be amiss to state that superintendents, engineers, owners or mechanics other than welders might with profit study principles of oxy-acetylene welding or cutting to advantage.*

*The author particularly wishes criticism of any points with which his readers may disagree; on matter not clear or needing further explanation; and of points not touched upon which a reader thinks of importance.—THE AUTHOR.*

### Difficulties Encountered in the Application of the Acetylene Flame

Before actual welding is undertaken on a serious scale, some knowledge is necessary of the difficulties met with. We must in most cases, secure practically the same characteristics in the weld as has the metal adjoining; yet we are bringing to a melting heat that particular section we are bonding and as the case may be, *oxidize, decarbonize or carbonize, porduce blow holes, destroy certain alloys and last set up a strain which results in the distortion of the article or its breakage*—unless we have a general understanding of these possible conditions.

To thoroughly understand them and be in a position to overcome them in all cases, not only would it be necessary to be an expert welder, but as well a chemist and a metallurgist. Yet, if we are without this *general* understanding, good welding is hopeless. We may with profit then study these conditions carefully and depend for the practical working out of some of the difficulties upon those who are equipped to technically go into these conditions—a flux may be made by a chemist, for instance, which will offset oxidation in certain cases. We need not know the details of the reaction; it is sufficient to understand that many of these adverse conditions may be overcome by intelligent application of knowledge which is within our understanding.

### Expansion and Contraction

The coefficient of expansion of metals is high. The foundryman, pattern maker or machinist would better understand this perhaps by reference to the modification always made in patterns "to allow for shrinkage." We all know that when the foundryman pours the metal, it occupies a larger space than it does when it is cold,—it is longer, wider and thicker. In other words, the metal shrinks as it cools and this shrinkage is greater with some metals than with others,—aluminum shrinks more than cast iron, for instance. Then if we again heat this casting it begins to expand just the minute it increases in temperature and keeps expandng with each degree of heat. *The coefficient of expansion is the increase for each inch of metal for each degree of temperature.* It isn't necessary to *melt* the metal to get this expansion. Slightly warm will get some, a red heat on iron will mean that it has reached about half its total expansion limit and as the metal melts, it has expanded as much as it can. As it cools, it shrinks in exactly the same ratio as it expands.

We will do well to read this again. While there is nothing new therein and it is well known that the power of expansion cannot be overcome, we believe that it is the lack of recognition of this law which is responsible for nearly all the failures of acetylene welding on salvage work and in many cases of construction as well.

We frequently see angle irons bolted to aluminum cases to *prevent expansion;* shafts run through bearings *to prevent contraction;* rigidly constructed jigs or clamps for the same purposes. All these devices may be used to help us in securing alignment, or perhaps aiding us in other ways—none of them can prevent expansion.

Foundrymen daily use the acetylene flame with no thought of the expansion set up, yet daily they provide for it in their own line. Machine shops, familiar with the shrinkage of cooling metals, forget all about expansion and contraction when making a weld and are puzzled when the article breaks or is so distorted that it is useless. Technical engineers, trained to recognize quickly this law of expansion and contraction, fail to take it into consideration many times in their consideration of the practical utility of the acetylene flame in boiler welding, high pressure pipe welding, etc., many times condemning the process, when it was simply their lack of understanding of its application.

Expansion and contraction is provided for in bridge building, boiler manufacture, in pipe line construction,—everywhere where metal is exposed to heat and cold,—and the reader is familiar with the method of laying railroad tracks, with a space between the rails to provide for the expansion of the metal, and its consequent lengthening, in the summer. If no attention is paid to the power of expansion, the rail would buckle,—clamping devices, the fishplate or spikes cannot prevent this, so *allowance* is made for it.

The acetylene flame brings to a melting point a small section; in addition, there is an area surrounding the weld which is heated, the extent of this area depending upon the *conductivity* of the metal. Since different metals, not only have different *melting points* and different *coefficients of expansion*, they likewise have different degrees of conductivity, i. e., one metal will transmit heat to a greater or less extent than another.

The following table is intended as a guide in aiding the operator in the intelligent use of the welding flame. The figures given are approximate in each case and not absolute:

| | Melting Point | Conductivity with silver 100 | Expansion per foot each 100F increase |
|---|---|---|---|
| Wrought Iron | 2700 | 12 | .007 |
| Mild Steel | 2650 | 11 | .008 |
| Hard Steel | 2550 | 10 | .008 |
| Grey Cast Iron | 2200 | 10 | .006 |
| Nickel | 2600 | — | .008 |
| Copper | 1900 | 74 | .0106 |
| Brass | 1750 | — | .011 |
| Bronze | 1650 | — | .012 |
| Aluminum | 1200 | 32 | .015 |
| Zinc | 850 | 20 | .017 |
| Lead | 650 | 8 | .018 |
| Tin | 450 | 15 | .016 |

If we but grasp the fact that *cold metal must occupy a smaller space than hot metal* and that we must always have hot metal in welding with the acetylene flame, we are well on the way to an understanding of expansion and contraction. In our use of the welding flame then, *we must always allow for the effects of either expansion or contraction.* How we can prevent ill effects depends upon the article we are welding; sometimes, but rarely, we need make no provision but wherever there is danger of warping, breaking, or shortening we may guard against them in one of the following ways:

1st.—*By heating the article all over, thus expanding the entire article, so that it will contract equally.*

2nd.—*By heating a section, which may be affected by the expansion or contraction of the welded area; and where the heating of the entire article is not necessary for the reason that the weld will not affect the entire section.*

3rd.—*By bending, separating the edges to be welded, dishing a patch—in these instances, we allow for contraction to straighten the line of welding, i. e., the fact that cold metal occupies a smaller space than hot is taken advantage of.*

4th.—*By limiting the expansion—holding the heated area to a small section by the use of water, metal plates of a higher conductivity, etc.*

No hard and fast rule can be given as to which method is applicable; we must be governed entirely by conditions as they present themselves but it may be well to repeat that until the operator grasps the importance of expansion and contraction and understands in a general way what it is, he cannot understand the details of guarding against failures which are illustrated in following chapters.

### Conductivity—Ductility—Volume of Heat in Relation to Expansion.

By referring to the table above we find that various metals have different melting points, different expansion limits and different ratios of conductivity. All these conditions must be taken into consideration when making a weld. The melting point, to a greater or less extent, governs the *size* of our welding flame but so does the conductivity. Aluminum, for instance, has a great conductivity, so we must use practically the same flame for aluminum as we do for steel, even though its melting point is only half that of steel; in addition, remembering that because aluminum conducts heat so rapidly, we must particularly guard against expansion and contraction, since the heated area is a big one and the shrinkage of the cooling metal consequently great.

From a welding standpoint, we may treat ductility and malleability as meaning the same thing. Wrought iron may be pounded for instance at almost any heat without fracture; cast iron on the other hand is brittle at all heats and will break quite easily. Aluminum is ductile cold and very brittle when highly heated or it may be brittle cold if alloyed with other metals as it is when it is used for castings. Copper is malleable except at a high heat, when it is very susceptible to fracture. We must bear these points in mind in planning our weld, since we may not always *break* a section by lack of attention to expansion and contraction—we may distort it however, if the metal is ductile or create a strain which may later break.

We must remember also that it takes *more* heat to melt a casting two inches thick than it does one only an inch thick. The same metals of course melt at the same temperature but we require more *volume* of heat on a thick piece than on a thin one—in other words the thick piece *absorbs* more heat. This fact has a direct bearing on our study of expansion and contraction, since often we are confronted with the task of welding comparatively light sections with heavy sections adjoining to *absorb* the heat of the welding flame and since the heavy section will absorb more heat, we may have difficulty in properly cooling the weld to prevent the heavier section *too* quickly absorbing heat from the light and thus causing a strain, since all parts must cool equally to avoid either breakage or warpage.

There is a tendency on the part of even experienced operators to pay no attention to the effects of expansion or contraction—often as they express it "to take a chance and weld it cold." These same operators too often think that bad luck is responsible for welding failures; whereas a little study and an application of one of the four methods of counteracting expansion or contraction previously outlined, would spell the difference between success and failure. Let us study carefully this general explanation of avoiding the bad effects of expansion or contraction so that we may in each case plan to overcome them.

### Oxidation.

If we have learned the adjustment of the welding flames, we find that we can secure several kinds of flames, one of them, and the most dangerous from a welding standpoint, being an oxidizing one—a flame having an excess of oxygen. All metals are susceptible to oxidation—the oxygen combining with the metal and forming an oxide—and this action is intensified as the metal is heated. Iron rust is one form of iron oxide and since we are all familiar with the weakness of iron which is badly rusted, we may conclude that the incorporation of oxide in a weld is to be avoided whenever possible. We may better be in a position to overcome oxidation by understanding how it may occur.

Water from the oxygen cylinder or wet acetylene, coming through the welding torch, may be deposited in the weld in the form of water vapors and cause oxidation.

Oxygen from the air may unite with the molten metal. The hydrogen contained in the acetylene, burning to water vapors, may produce oxides.

A welding torch, improperly designed, not uniformly mixing the gases, may have an excess of oxygen, without being noticeable to the eye, and this oxygen will unite to form a metal oxide.

And finally, we have the flame which is carelessly adjusted to give an oxidizing cone, which probably is the most common way of causing oxidation and the avoidance of which depends wholly upon the operator.

As the case may be, we must be careful in our choice of apparatus, in the manufacture or purchase of the gases, and in the adjustment of our flame to avoid oxidation but even with all this care exercised, oxidation will take place to some extent and we must then depend upon other sources to remove these oxides or to minimize them—by allowing cooling, by the use of properly prepared welding rods and correct fluxes.

The welder must not be discouraged by a recital of the causes of this troublesome feature—if we understand causes, we are very likely to excercise care—and the oxidation of metals is one of the very serious problems we have to contend with in the joining of metals by the acetylene flame. The welder may not see this oxidation—the weld may have the appearance of being good—so he should know that if it takes place, the weld is deficient in strength and therefore should take particular care to see that the oxides remaining in the weld are as limited as possible. How to more fully guard against oxidation will be taken up under later subjects.

### Effect of High Temperature on Metals.

Since acetylene welding is a fusion of metals by the use of a high temperature flame extremely concentrated and unlike melting metals where a crucible is used, we bring the flame into direct contact with the metal; in metals where alloys are used, we must guard against the action of a high temperature on these alloys.

The various brasses and bronzes, for instance, contain certain proportions of zinc or tin, or both, and the other element, copper, melts at a considerably higher temperature than the alloys, as we will note by the table of melting temperatures. Then we must burn out of this mixture more or less of the alloy which melts at a lower temperature than the copper and if we do this, we must use a welding rod and a flux which will put back into the material as nearly as possible the material which we have destroyed. To a large extent the burning out of lower melting metals is prevented by the proper use of the welding torch; but since we cannot entirely do so, care must be used in the choice of chemically correct welding rods and fluxes.

Cast iron and steel contain varying proportions of carbon. To obtain a true weld, we must have the weld as near as possible the same material as the metal itself—neither more nor less carbon—and next to oxidation this is the most difficult problem for the welder to realize. Carbon has a high affinity for oxygen and unites with it very easily, forming a gas, and resulting in a porus condition of the weld and a reduction of the carbon content, as well as a reduction of the strength. In the case of cast iron, we may incorporate in the weld additional carbon by the use of a proper welding rod and fluxes, but in those steels which have a high carbon content, we cannot do this and a weld on high carbon steel must be made with the fact strongly in mind that it will be deficient in strength. Taking out the carbon is called *decarbonization*—the action is not unlike oxidation, from the workman's point of view, since it takes oxygen from one of the sources named previously to produce it. The welder may practically treat it as oxidation, remembering that it can be produced only on those metals which contain carbon—cast iron and steel.

As we can take out carbon, so also can we increase it, since the acetylene flame is rich in carbon and carelessness in adjusting the welding flame to a carbonizing cone will increase the carbon content to a point where the steel or iron welded may be extremely brittle. Since a carbonizing flame is quickly recognizable by its shape, as well as by the fact that it is not nearly so hot as neutral welding flame, the operator should not experience any particular difficulty in guarding against carbonization, if the welding torch is a proper design. Decarbonization, however, like oxidation, can take place easily by a careless adjustment of the welding flame, since a cone of an oxidizing character is so easily obtained unless the operator has learned to guard against it.

Any of these reactions, the burning out of an alloy, the adding of carbon or its taking away, may cause pin holes or blow holes in the weld. Molten metals absorb gases, either from the atmosphere or from the flame, and either give them up, or partially give them up, upon cooling. If the molten metal does not entirely give up the gases, then we have blow holes in the line of welding. Largely, they are prevented by the proper use of the welding torch and upon slow cooling, better understood under later subjects devoted to each metal. The incorporation of dirt in the weld may also cause blowholes.

We may change the mechanical properties of a metal by melting it as we do with the acetylene flame. Case hardened steel, for instance, is no longer hard when it is welded. Copper may lose its ductility and require annealing. Drawn brass or pure aluminum become castings and forged and rolled iron and steel no longer have exactly the same properties, since we have melted the line of welding and the mechanical construction is not the same—the molecules of the metal are not so close together, for instance, since the weld has not been subjected to any hammering or rolling.

We may become welders of a sort without a knowledge of these difficulties; we can never become good operators until we know something about them and how to overcome them, as they may present themselves, and we must again call attention to the necessity of having each portion of the apparatus correctly designed, the gases pure and intelligent operation essential before we may hope to produce the best results. Anything less than the best should not satisfy us and from any standpoint there is a reward as substantial, as it is self-satisfying, when we have accomplished this.

### Welding Rods.

To bring the welded section up to the same or a greater thickness than the metal joined, as we may desire, we must add material in the form of a rod or wire. If we have understood the importance of having the weld as near as possible the same material as the metal, it behooves us to use the greatest care in our selection of the welding rod, since it is this material which composes the greater part of our line of welding. Not always do we use a welding rod of the same material as the article welded; sometimes certain alloys are incorporated in the rod to offset the action of the high temperature of the welding torch; we may use a high percentage of a low melting alloy, for instance, in the rod to make up for its loss in the weld. We may use mild steel of a very low percentage of carbon and, with all impurities eliminated, to offset as much as possible decarbonization. And, as the case may be, incorporate in the rod certain agents, such as silicon for cast iron and phosphorous for copper, and these elements prevent deleterious effects, the cast iron remaining soft and the copper maintaining its ductile qualities.

Welders of limited experience are very likely not to appreciate the knowledge necessary to properly manufacture a welding rod, yet hard welds in cast iron, steel welds deficient in strength or porous, copper joints brittle and aluminum bonds contain a large quantity of oxide, unless the welding rod is correct. The welder cannot judge the rod by its appearance or wholly by its action under the welding flame and the purchase of the rod, so often made in a careless mannner, should be one of careful choice.

The hardware store or the mail order house or the local foundry are not in a position to supply this valuable adjunct. Its manufacture in a proper manner should be supervised by a chemist thoroughly familiar with the high temperature of the acetylene flame and it should then be tested by experts in actual use. Naturally, the supply house from which all welding rods should be purchased is the one combining this chemical knowledge with the practical use of the welding flame, which is usually an apparatus manufacturer. Tremendous progress has been made recently in the manufacture of welding rods, and the almost constant improvement of them by those apparatus manu-

facturers who maintain a laboratory and testing room enables the user of the acetylene flame to successfully weld many articles which have been either unsatisfactory or impossible to handle.

We must not be guided by price quotations in the purchase of welding rods; we are not able to specify simple cast iron or steel, aluminum or copper rods, but should purchase the welding rods to weld these various metals which are specially prepared by technically trained forces understanding fully the chemical, as well as the mechanical requirements.

### Fluxes.

Sometimes we are able to prevent oxidation or to remove the resulting oxides from the weld when we cannot prevent it; we may, to some extent at least, offset decarbonization; oppose any material change in an alloy or better maintain ductility of a metal by the use of powders or pastes which are termed *fluxes*. The duty of the flux, then, is to oppose or offset certain chemical changes which will be detrimental. It must contain no ingredient which will have a harmful effect on the metal certainly; it should aid in bringing the metal together—that is, by an increase of its fluidity; it should not melt and vaporize at too low a heat and thus not accomplish its purpose in preventing oxidation or decarbonization, as the case might be, and it must not melt at so high a heat that it will remain in the weld. Its weight also, compared with the metal or the metal oxides, is a factor of importance. Necessarily, the manufacture of a flux *as a rule* should be carefully carried out and the welders are not equipped to properly prepare or make most fluxes. Inasmuch as they are quite inexpensive in nearly all cases, we should leave their manufacture to those skilled in this line and purchase them with a positive guarantee.

---

## WELDING IN THE JEWELER'S SHOP.

By B. Kopferschmidt.

Ornamental jewelry was known in olden times and it appears to have been among the very first objects on which the inventive genius of man was exercised. The metals chiefly used since the days of old have been gold and silver, but in modern times platinum has come to be universally used. The workmanship of the old Egyptians, Romans and Greeks, was in some cases of a character which modern goldsmiths can only rival, and can never surpass. The modern goldsmith, however, has at his command one facility which the ancient workman did not possess, and that is the art of welding by the oxy-acetylene method. Could he have but had this wondeful tool in his working equipment, we can only imagine what he would have produced in the form of rare jewels.

The ancients were taught to join precious metals by the soldering method. This method, however, was unsatisfactory, because the process left the soldered joint of a whitish color, which impaired the appearance of the jewel. Later this method was superseded by the brazing method, and to this day jewelers braze with the aid of a mouth blow-pipe, which is of course a slow and laborious method, and not to be compared with the modern method of oxy-acetylene welding.

In nearly all the great cities of Europe and America, where jewelry is produced in great quantities, skillful jewelry welders are plying their trade, and with the aid of delicate, although efficient, little oxy-acetylene welding torches are producing the intricate and wonderful jewels of today. Plain welding is not the only use to which the welding torch is being put, but annealing processes, as well as the creating of special finishes has also come to be a part of the manufacture of jewelry.

Consideration of the methods of the present native jewelers of Turkey, or the Gypsies in Roumania, with American jewelers, furnishes an interesting basis of comparison. These strange workmen, traveling after the fashion of the "tinker" in England, journey from town to town. Their "budget" contains tools, materials, fire-pots, a small oxy-acetylene welding outfit, two small oxygen and acetylene cylinders (25 cu. ft. each), and all the other requisites of the handicraft. The gold or silver to be used is generally supplied by the patron, or employer, and in most cases in coin, which the traveling jeweler undertakes to convert into the ornaments required.

He squats down into the corner of the court-yard, or under cover of a veranda, cuts up the gold or silver pieces entrusted to him, and melts it into the fire-pot by the aid of the welding torch. He then hammers, anneals, cuts, shapes, drills, welds, files, scrapes and burnishes the piece until he has produced the desired effect. He never seems to make a mistake and his instinct for harmony, color and design, is as unerring as that of the bird in the construction of the nest. This furnishes a concrete illustration of the many and varied uses of the welding torch and the unexpected parts of the world in which the process is used.

On the other hand many, in fact a very great many, of our American jewelers, with their beautiful corner stores and elaborate and modern show-rooms and work shops, have failed to recognize the value of the oxy-acetylene welding torch and substitute it for the antiquated mouth blow-torch.

The writer of this article does not profess to be an expert welder of precious metals, but in the past he has welded successfully many articles of gold, silver and platinum. No special skill is required for this class of work. It is similar to the brazing method, with the exception that the metal is brought to a fusing point, instead of a red heat, as for brazing. Flux is unnecessary and the welding wire is, of course, of about the same grade as the article to be welded.

Some time ago while on a visit to a welding shop in a large city a well-to-do gentleman came into the shop in a great hurry. He had a platinum ear-ring, the setting of which was broken. He had been told that it might be welded, but the manager of the shop I was visiting advised him to take it to a jeweler. He replied that he had visited every jeweler in the city, but had been advised that he would be obliged to buy a new setting from a distant city, where the ear-rings had been purchased. The jewelers stated the ear-ring could not be welded, explaining that even if the metal could be brought to a fusing point, the whole setting might be melted during the operation. The trinket was of a beautiful design, in the shape of a balloon, made up of very thin strips, uniting on the ends with two large diamonds. One of these strips was broken in the middle.

The ear-rings were intended, it seems, as a birth-day gift to this gentleman's daughter and were to be presented that same evening. Naturally I became interested in the problem and after carefully contemplating the task I informed the distressed gentleman that I could weld the broken segment without damaging any part of the ear-ring. Upon my advise the owner then went to a jeweler and had the diamonds removed, also purchasing a small strip of platinum to be used as a welding rod. On his return I buried the whole setting in a fire clay mould, mixed in the form of putty, leaving only the broken strip exposed to the flame. With the aid of a very small blow-pipe and a No. 3 tip, I brought the broken edges to a fusing point in a very few seconds, the broken edges uniting almost voluntarily. I will not attempt to describe the owner's state of mind, nor his excited expressions when he saw the intense white heat of the fire clay. He undoubtedly thought the entire jewel was a molten mass. However, when I dipped the jewel in water to loosen the fire clay, and washed it off again, the owner of the jewel, as well as the manager of the shop, were surprised to find the ear-ring was as good as new.

I think perhaps the jewelers of this city did not undertake to repair this jewel because they could not get the two

thousand degrees necessary to bring the metal to a fusing point, without melting or destroying the balance of the article. This job, however, simply illustrates the very wide application of oxy-acetylene welding to the jeweler's art. Many a so-called "impossible" job could be handled with its aid, in addition to eliminating the soldering or brazing systems, with their many shortcomings.

There are quite a number of manufacturers who are manufacturing welding torches for the dental trade, and this apparatus would, of course, answer the purpose of the jeweler admirably.

---

## THE IMPORTANCE OF PROPER BEVELING.

By J. B. Diehl.

To the beginner this may seem a trivial matter, but if this subject is given careful consideration one may readily appreciate the importance of proper beveling from a practical standpoint.

It appears to the writer that one of the greatest injuries done to the welding industry is the fact that there is *too much* surface welding done.

The general tendency of the beginner is to sacrifice strength for neatness, appearing easier to make a neat surface weld than to make a thorough weld; therefore, the importance of proper beveling and fusing should be impressed upon the beginner's mind. In time this will become habitual, followed rapidly by neatness, and the degree of a first class welder if the operator is conscientious.

On such metals as steel, cast iron, brass, bronze, copper, malleable iron and monel metal, a 90 degree groove should be formed from one side on thicknesses ranging from one-eighth to three-eighths of an inch, and in some instances one-half inch. Anything heavier than this should be prepared from both sides whenever practical.

By using the puddle system on aluminum of ordinary thickness, beveling is not necessary.

Here the question will arise in the mind of the novice as to why anything over three-eighths-inch should be prepared and welded from both sides. This may readily be understood by referring to sketches number one and two.

Number one illustrates preparing a piece 1x1x6 inches from two sides, so that there is a rembrant angle of 45 degrees at their junction, while sketch number two is prepared from one side.

Assuming these are broken in the center, we have divided each piece into six one-inch cubes. Upon cutting two 90 degree grooves in number one, we find we have removed one-half of a cubic inch of metal, whereas by cutting one 90 degree groove in number two we find the aggregate amount of metal removed is one cubic inch. Therefore, if twice as much metal is removed by number two method as is with number one, it is necessary that twice the amount of time be expended in preparing, twice the amount of filler material to be added, entailing the use of twice the amount of time and gas resulting in the customer being overcharged, or the firm losing money.

The dotted lines in sketch number three show four angles as in number one placed in the large groove, showing the folly of preparing from one side where it is practical to prepare from two sides, and why twice as much metal is removed.

Here we may be confronted with the question as to why the 90 degree groove is used. In the first place this is necessary in order to first melt and join the apex or bottom of the angle. If these angles were changed from 45 to 60 degrees, it would be exceedingly hard to reach the bottom of the angle without first melting the sides or top. Where this is allowed to take place, the molten metal will flow over the bottom and not being fused to the bottom will cause a weld that is not reliable. Of course, we may then dig into the metal with the flame, but this method should be shunned as it is not always practical. This method used on brass alloys would result in the zinc being burnt out causing pin holes; on high carbon steel, the carbon would suffer and other metals according to their nature.

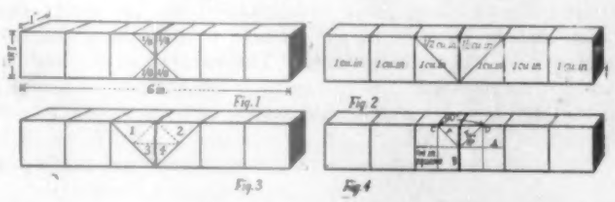
Then speaking of changing the angle from 45 to 30 degress, we have but to refer to sketch number three where the detriment of making the groove two wide may be readily understood.

Therefore, for proper welding, using a minimum of gas and time the 90 degree groove is the only one that should be used.

To form the 90 degree groove:

An easy method of explaining to the beginner how the 90 degree groove is formed is illustrated in sketch number four. The center is determined first, line A B shows the fracture. As the distance to the center is one-half inch, lines are layed off the same distance from each side of the fracture. C and D forming four squares.

Two lines are then drawn diagonally F E across the




squares, on a 45 degree angle, forming the 90 degree groove.

These lines may be carried to the bottom of the piece forming the two grooves at one time if desired, or layed out separately.

Where the grooving is to be done from one side only, the distance on each side of the fracture should be equal to the thickness to form the squares. By laying the work out in this manner, the beginner not only does good work, but speedily becomes so accustomed to this proper angle, that he does not find it necessary to lay the angle out at all.

Parts having the double groove should never be cut from top to bottom without leaving about one-sixteenth of an inch of the original metal in the center, as all points of contact would be destroyed. It is necessary in this case to cut from both sides.

Some operators prefer leaving several points of alignment, but after close observation the writer believes better results are obtained by leaving only the center or bottom, according to circumstances, eliminating all possibility of leaving parts unwelded. By this method the original shape or dimensions are determined first and after preparing, the part is placed to correspond with the previous alignment preparations, assuring the operator of a reliable weld with the original dimensions.

---

In electric butt-welding ¾x⅛ in. wall tubing in a plain machine such as is used for welding solid bars, we experienced difficulty due to uneven heating of the parts.

To overcome this trouble we inserted a piece of ⅜ in. cold-rolled 1½ in. long in the tube. We have welded 10,000 front-axle tie-rod tubes in this manner.—*American Machinist.*

---

A workman in any line must have a knowledge of the tools he uses. The oxy-acetylene operator is no exception to the rule.

# WELDING CAST *and* STEEL SPOKES

## *A Practical Discussion of Methods of Preheating and Welding of Difficult Spoke Jobs as Practiced in a Railroad Shop*

*By* Nels Johnson

IT is a fact well known to all mechanics, and welders in particular, that all metals will expand a certain amount when heated, and that any article made of metal, thus expanded from heat, will contract and come back to its original size and shape when allowed to cool.

This everlasting expansion problem that the welder nearly always has to take into consideration in his work, has been, and is now, quite an obstacle to overcome, for the beginner in the welding trade. The success of the welder depends largely upon his ability to judge the proper amount needed for expansion and contraction, and often how to get enough, or any at all.

Fig. 1 shows a photo of a cast iron drive-wheel center, in

**Fig 1. Locomotive Drive Wheel.**

which nine welds are made. That is, two welds are yet to be made when picture was taken, the job being done at M. & St. L. R. R. Shops, Minneapolis, Minnesota. I have welded a number of cast iron and cast steel spokes with good success. I do not consider it to be any great trick or require unusual skill, but seeing inquiries made in *The Welding Engineer* on how to handle such work, I will try to explain how I handled this job. Perhaps some one may benefit from my experience.

After placing the wheels on trussels, so that they could be turned around freely, the tire was first removed. The rim of the wheel being solid, I cut the rim in four places, as shown in Fig. 2-A-B-C-D. The five spokes in the counter balance were all broken about ¼ inch from the hub, as shown in Fig. 2. The sketch also shows the breaks on the other three spokes.

After the rim was cut, I removed the parts thus loose from the wheel and chipped the ends of the broken spokes in V shape, leaving the stub of the spokes flat as broken. After this was done, I cut four straps of iron ½x1½ and bent same edgeways, the radius of the wheel. After placing counterbalance back in position, holding same in place by the four straps of iron and screw clamps, giving the center spoke (3) ¼ inch for expansion, I was ready to begin welding.

You will notice that the five spokes in the counterbalance ready to be welded would, if loosened and heated, expand and lengthen in different directions. This must be taken care of. Cast iron spokes will not stand unfair treatment. They will break with a bang when cooling, if not let free to expand when heated.

'I first welded spoke 2 and 4, at the same time, building up from the bottom. It being hard to bring the stub ends of the spokes to a fusing point, on account of the spokes being broken so close to hub, I used one torch for heating only and two for welding. After the spokes were welded and filed off I packed dry asbestos around the welds and allowed the wheel to cool slowly. I next welded spoke 5. By heating spoke 4 to a dull red, thus expanding same, I got ¼ inch expansion needed for spoke 5, there being spring enough in spoke 2 to allow for that. Spoke 4 was kept hot while spoke 5 was welded. The wheel was allowed to cool again, dry asbestos being packed around the hot spokes.

I next welded spoke 1. By heating spoke 2 to dull red, and spoke 4 not quite as hot, I got ¼ inch expansion for spoke 1. Spoke 2 and 4 were kept hot during the time spoke 1 was welded, and the wheel allowed to cool again, as before mentioned.

Quite a number of the men in the shop were interested in the job as it progressed and I was told that the spoke I left to the last should have been welded first. However, I could not agree to that.

I first heated counterbalance in order to lengthen same, kept one torch busy heating spokes 4 and 5, and one on 1 and 2, while I welded spoke 3 alone. When done welding, all the five spokes were dull red. Dry asbestos was again packed around the hot spokes and allowed to cool.

The other three spokes were not as hard to handle, there being no counterbalance to contend with.

After clamping the rim in place both breaks on spoke 7 were welded. There being spring enough in the rim to give a little, I welded spokes 6 and 8 without allowing the wheel to cool. When done all four welds were again heated to the same heat and allowed to cool, asbestos being packed around as before.

Some one may ask, why not take advantage of the heat and weld the spokes in the counterbalance one after the

other? Perhaps it could have been done, but the whole center of the wheel being hot and expanded, I could not tell if I had the proper amount needed for expansion and contraction. By allowing the wheel to cool, I "knew where I was at." I decided to take no chances.

One-fourth inch is more then needed for expansion and contraction, but the wheels being out from under the engine, I allowed enough to take a light cut in the wheel lathe after the job was done. When the tire is put back without first turning the wheel, ¼ or less is sufficient, depending on the length of the spoke, and where the spoke is broken.

The cuts in the rim were of course not welded up again, steel blocks being fitted in.

All engine drive-wheels are made in sections anyway nowadays, there being as a rule 4 and 5 spokes in each section. In such a case it is not necessary to cut the rim any more. By heating the spoke, or spokes, next to the one to be welded, it is not hard to get all expansion needed for any of the spokes.

As to the proper amount needed for expansion, I can only say that the welder must use his own judgment. All spokes are not alike. A long spoke broken in the center needs ¼ full, while for a short spoke broken next to the rim, or hub,

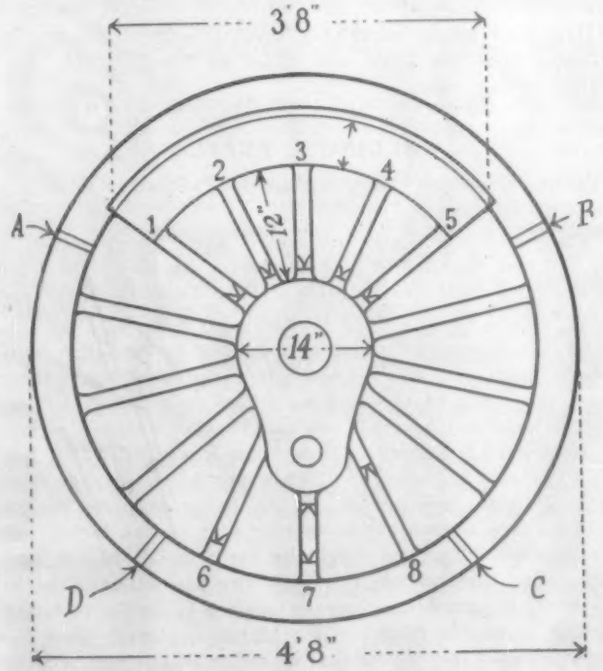



**Fig. 2. Method of Welding Spokes in Locomotive Drive Wheel.**

⅛ may be sufficient. It is well to leave spoke ¼ too long, but one should always avoid to make spoke too short.

Cast steel spokes are handled in a similar manner. However, a little less should be allowed for the expansion. The tire should always be removed if you want to be safe. Although in emergency cases I have welded steel spokes without removing the tire, thus nothing being allowed for the spokes to expand. But when not allowed to expand, it must upset, and when cool the spoke or spokes always pull the rim away from the tire, showing that an awful hard internal strain must be in those spokes. Some of the spokes welded in that manner broke after a short time, (not all) but of those welded, tire being removed, and when necessary, the rim cut, the spokes being set free to expand and contract, I have not met with a single failure.

It is said the new process of welding is still in its infancy. Truly it is. It is still in the experimental state to a large extent. In time to come we will look back on the work we have done today and see the same difference and progress made as we do when comparing methods used fifteen or twenty years ago with the modern methods of today.

It appears, however, at least as far as welding is concerned, we have not patience enough to let it develop. When the operator gets bad results he himself, and others, are hasty in blaming the method. It is called "no good" and often thrown out of use. There is nothing wrong with the method. If you meet with failure it is because you have not learned the art of welding. There is no such a thing as good luck, or bad luck. You are getting results according to your ability.

If you have a problem in mathematics to work out that is very deep, and you are not able to solve it, you would not say that you failed on account of hard luck. If determined, you would educate yourself instead, and learn how.

So with the welding. Every failure is caused by not properly performing the work. It is up to the welder to study his work and learn from his failures the cause of bad results. Before we learn the cause of bad results, we are not able to avoid them.

---

## DIE CASTINGS—THE COMPOSITION AND REPAIR OF.

By J. B. Diehl.

As the repair of die castings appeared to be a stumbling block in the welding shop, the operator should acquaint himself with the constituents of this peculiar alloy, and the possibilities of its repair.

The repair of these castings does not always present a practical aspect in the welding shop, as more time is required to make a repair of this nature than to make a weld of the same dimensions on other metals, due to special preparations having to be made and more time is spent in the repair operation.

These castings are used, wherever practical, in place of other metals, due to the fact that they can be manufactured and sold at a comparatively low price. However, the occasion often arises where time is the main factor, and the customer will gladly pay any reasonable price to have the repair made quickly.

It is a common occurrence for a die casting to be brought into the welding shop, where the operator is at a loss to name the metal, or to determine its character. Whereas, if he were able to explain intelligently the nature of the metal, and the approximate cost and strength of the repair, even though the customer would decide not to have the repair made, he would be more liable to place other intricate repairs in the welder's hands, feeling that he thoroughly understood the welding business.

### Composition of Die Castings.

The words "die casting," are taken from the mechanical operation of "casting by the means of dies."

Any section or part that can be machined, can be die cast, as the accuracy will be within 0.001 inch on all dimensions whether inside or outside if the dies are made properly. This largely depends upon the judgment used in computing the shrinkage of the various metals in the composition.

Machine work is eliminated in die casting, owing to the above stated accuracy, and as the hot metal comes in contact with the dies, a skin is formed similar to that on a sand casting, which materially strengthens and adds to the wearing qualities of the metal.

From a metallurgical standpoint, die castings are considered superior to sand castings, being denser, stronger and with fewer blowholes if cast properly.

Die castings are easily distinguished from aluminum owing

to the weight being considerably greater, while the color is several shades darker than aluminum.

It is possible for an inexperienced person to mistake Britannia metal for die cast metal owing to its weight, but as this is a white metal, having its use confined to the household it is seldom encountered, although it is well to understand the uses and nature of this alloy, which consists of 50% antimony, 25% bismuth and 25% tin.

The best die castings are made from alloys of the following metals: Lead, tin, zinc, antimony, aluminum and copper, although the majority of castings made now are mixtures of lead, tin, zinc and antimony.

The shrinkage varying from 0.002 to 0.007 of an inch per inch frequently depending upon the shape of the article.

Those having a zinc base will shrink considerably, while those of the tin base shrink very little. However, the operator need have no apprehension of shrinkage cracks in making repairs if a good filler material is used.

It is necessary to use an alloy having a tin base on carburetor parts or parts coming in contact with gasolene, or parts coming in contact with food products, as the lead or zinc alloys have a contaminating effect.

The three most prominent alloys in use are: The zinc base alloy containing 85% zinc, 8% tin, 4% copper, 3% aluminum melts at 852 degrees Fahrenheit. Owing to this being a cheap composition it is most commonly employed, but having very little tin in the mixture it cannot be called the best. This alloy will rapidly deteriorate with age, and is noticeably affected by the heat and cold.

The lead base alloy containing 80% lead, 15% antimony, 4% tin and 1% copper melts at about 550 degrees Fahrenheit, and is used where little wear and no strength are required. Owing to its weight, it is mostly rejected as a solution to auto parts manufacturing problems, and it is very brittle due to the large percentage of antimony.

The tin base alloy containing from 70 to 90% tin, 4 to 15% copper and a small percentage of antimony, depending upon the manufacturers ideas, melts at 675 degrees Fahrenheit and makes the best die castings available.

### Method of Repairing.

Die castings are very easily determined by the use of the welding torch. As the flame is applied, the skin will break into small particles and fly about, while a white smoke will arise due to the zinc vaporizing, the action being more pronounced on castings having a zinc base.

Where the metal is over ¼ inch thick, the fracture should be prepared as in welding for best results. The skin or oxide should be ground off for a space approximately ⅜ of an inch around the fracture, this being essential, as the oxide melts at a higher temperature than the alloy and is troublesome if allowed to become mixed with the metal.

Owing to these parts being small as a rule, it is advisable to clamp them on a table to allow the operator free use of both hands. If the parts are of a hollow construction, or liable to drop out of alignment when melted, a form should be fastened beneath that section, and using a good aluminum solder as a filler rod. Care should be taken in selecting the solder that it does not contain a high percentage of zinc, as this is a troublesome factor in repairing die castings. The high percentage of zinc is used to make the melting point of the solder very low.

A soldering iron is used, having the surfaces filed clean of any other solder, and no acid is necessary to make the joint. A small iron can be used more advantageously than a large one, but as the small iron does not hold the heat long, it is often advisable to play the flame of the torch against it in such a manner as to supply the necessary heat. Care must be taken not to allow the flame to play on the casting, as it is impossible to make a repair of this nature with the welding torch, owing to the melting point of the metal being low, and the danger of burning the zinc out of the alloy.

A small piece of solder should be layed on the fracture and worked in with the iron, while the heat is supplied from the torch.

It is not necessary to preheat die castings, also not advisable, on account of its low melting point and upon completion of the repair it will be found that the metal is quite hot throughout. The metal can be kept under control easily, and built up to the desired height, reinforcing wherever possible, care being exercised to remove all oxide.

If a soldering iron is not available, a steel rod may be used, similar to those used in the puddle system for alumium, heating it with the torch as explained with the soldering iron.

While this method is practical, it is not as good as the soldering iron owing to the fact that as the iron becomes red hot, oxide will form on the rod and incorporate in the alloy. This oxide should be removed to secure good results.

Water should be kept handy to dip the rod as it becomes too hot.

If a good filling material is used, it will be found upon finishing that the joint will stand up equal to any other section of the casting.

---

## WELDING A KETTLE.

In the December issue we advised a reader to weld a crack as follows:

"Place kettle in fire in position it would occupy when in use. When thoroughly preheated turn on side with crack to fire and weld from inside. This expands metal and opens crack, which contracts when cooling."

Our correspondent reports that this method has been tried, without success. We now advise the following method: Bevel the crack to 45 degrees. Place on a brick platform so that weld can be made without altering position of kettle after weld is started. Do welding from OUTSIDE kettle. Preheat as follows: Kettle should be raised from brick platform four or five inches, being properly braced. Build furnace around kettle, leaving four or five inches fuel displacement. Furnace should be three inches higher than kettle. See that bottom row of bricks are seperated about one inch, to provide necessary draft. If kettle is larger than 36 in. use four or five old ¼ tubes, placing them between bottom row of bricks, in order to permit draft to reach center of furnace. Fill furnace with charcoal up to top. If casting is thicker than one inch mix charcoal with one-fourth coke. Light fire through draft holes with torch. Cover furnace with sheet asbestos. See that heat is gradual and uniform. In case kettle gets too hot on one side cover draft holes on that side with fire clay. Do not attempt to weld unless whole casting is cherry red. At this point take off asbestos (at crack only) and make weld, beginning at lower end, building up forward until finished. After finishing casting must be dull red. If it is not, add charcoal and continue heating. When dull red cover draft holes and crevices with fire clay and cover top of furnace, using layer of bricks. Allow casting to cool until hand can be placed on bricks, then remove furnace. If casting is one inch thick or over it will take 24 hours to cool. In order to make weld at one time and in one position it may be necessary to make a vertical weld. If so use carbon blocks or 1-in. fire brick on outside of bevel, building up metal as in building a lug. See that added metal unites with both sides of bevel.

Editor.

# A STRAIGHT TALK *with the* OXY-ACETYLENE INDUSTRY

*It's a Tough Job to Win Any Game Without Team Play—The Basis of Success Is Co-operation—Let's Discuss Openly the Things We Are Thinking About, and Make the Welding Trade into a Homogenous Body—Do a Little "Welding" at Home*

*By* M. Keith Dunham

I'VE asked the editor of *The Welding Engineer* for sufficient space to talk plainly to the oxy-acetylene industry—to apparatus manufacturers, carbide interests, dissolved acetylene and oxygen gas men and to users of oxygen and acetylene who have the welfare of the industry at heart.

No one interest or set of interests has asked me for this talk—I'm simply butting in, to put it slangily. I'm using the personal pronoun to emphasize that I'm acting solely as an individual and not as the representative of any company or of this paper.

Those men in the industry who know me are aware that I represent no apparatus or gas company. Those who do not know me must take my word that while I am partisan so far as the process of welding is concerned, being a firm believer in oxy-acetylene, I am truly neutral so far as any particular equipment or method of making gas applies. I'm selfish in my views to the extent that I'm a rooter for the oxy-acetylene process and that as this process is more universally and successfully employed, so also will the value of my services increase to the users and thereby I hope to benefit in a material way.

All this is written to disabuse any reader's mind from the possible thought that I have any particular axe to grind. To repeat, I'm butting in because I think it's about time someone did.

"In Detroit for instance, the authorities seem convinced in their own minds that all welded joints must be absolutely eliminated from refrigerating equipment. No one can blame them particularly for the decision *in view of the fact that no representative organization in this trade has presented any authoritative data to convince them to the contrary.*"

The foregoing is an editorial from *Refrigerating World*. The italics are my own. Detroit isn't the only place where legislation prejudicial to welding is being seriously considered and it seems to me that the time is ripe to talk about these things. We must recognize that accidents are occurring and that welding is being justly or unjustly blamed. But simply sitting back and *saying* that welding isn't at fault doesn't cure the trouble. We've got to *prove* it.

Listen: A couple of months ago, a welded ammonia container in a New Jersey ice plant—everything new and just being tested—blew up and six men died from the effects of the ammonia fumes. Who or what was to blame for this accident has not yet been determined but these facts are established: The tank which exploded was welded and the engineer in charge of the cause of this accident is an almighty good refrigerating engineer but has had no experience in welding. Although I have been in quite close touch with this accident, I have yet to learn of any oxy-acetylene men investigating it with a view of protecting the industry from possible censure and legislation.

New Jersey and Michigan are not the only states considering legislation against welding. What an opportunity for a legislator to make a hit with his constituents by drawing a bill forbidding welding and how quickly measures of a similar nature are passed in most states, drawn by men totally unfitted to pass upon the merits of the bill, is a matter of history. Once enacted it is a terrific job getting these fool laws off the statutes.

I am citing refrigeration welding alone because it was my pleasure last month to listen to an able address by John E. Starr of New York before the American Society of Refrigerating Engineers, in the course of which he defended welding. Incidentally, Mr. Starr urged the members of the society to protect themselves against unfair legislation by getting together data regarding accidents and have it ready for use when unfair bills pertaining to refrigeration are presented to various state legislatures.

But while Mr. Starr is favorably disposed toward welding, there are many members of the Society of Refrigerating Engineers who severely condemn it. Prominent among these men is Prof. Miller of the Massachusetts Institute of Technology. Some time ago, Prof. Miller, acting in conjunction with Mr. Fairbanks, a very well known refrigerating engineer, recommended "that oxy-acetylene welding should not be used for tension work except very small diameters, say 4 inches; it is not so much that it cannot be done as it is to know that it is done properly."

If in the opinion of men as high in the engineering world as these two gentlemen undoubtedly are, welding should not be used on tension work, what a fine chance the oxy-acetylene industry has, in its present state of unpreparedness, of convincing a legislature that welding is not at fault, particularly when this legislature can quote such eminent authorities as Prof. Miller of the Massachusetts Institute of Technology to the contrary?

Why do engineers, highly trained in their professions, refuse to recognize that oxy-acetylene welding is practical, safe and cheap on tension work if it is properly done? From memory let me tell you a few things about the meeting of the Refrigerating Society. At the conclusion of Mr. Hollup's paper, a gentleman asked the difference between oxy-acetylene and electric arc welding and was answered that there was no difference. Another gentleman, addressed by the chair as "professor," stated that he had made several examinations of oxy-acetylene welds and in each case found that they were highly carbonized and that in his opinion such a condition warranted the belief that all oxy-acetylene welds were brittle and not to be depended upon. An elderly gentleman, evidently at the head of some refrigerating construction company, went to the blackboard and illustrated his talk with diagrams. He emphasized the importance of bringing the metal into fusion (the one practical point

I heard brought out) and then stated that the proper way to make a weld on a seam was to add only a little metal at a time, welding the complete length of the seam for instance on the bottom only and then coming back and adding a little more metal for the entire length and so on until the weld was completed, meaning I suppose that on metal half an inch thick the weld should be gone over five or six times for the length of it. Another engineer stated that he had had the best of success with welded joints because he always threaded the two pieces to be first bonded and then made, what we in the oxy-acetylene industry term, a filiet weld.

Mark you carefully, this society is composed of engineers and this welding talk is not one whit exaggerated. Do you men in the oxy-acetylene industry wonder why tension work is frowned upon by Prof. Miller when engineers have so failed to grasp the elemental principles as to refuse to recognize the importance of expansion and contraction in welding, the trapping of the oxides in the weld, the adjustment of the flame to a neutral character and the proper preparation of the joint to be welded?

And do you men in the oxy-acetylene industry realize just how much help you can expect from a society discussing welding in this manner when it comes to the point where some defense must be made against unfair legislation?

It's a mighty short step from refrigerating welding to boiler welding or in fact to the welding of any liquid or gas or air containers and if legislation against welding is started (as it surely will be) it probably won't stop at refrigerating welding.

We don't want fool legislation. If laws are to be passed governing what shall or shall not be welded, or who shall or shall not be declared equipped to make these tension welds, the oxy-acetylene industry should guide the making of these laws. We all realize that daily some inexperienced welder is tackling a job about which he knows nothing and that the failure of his weld may endanger life. Very well, let's admit it and talk about it and take some action ourselves looking to the proper licensing of men competent to make such welds and ourselves decide how and when and by whom such welds may be made. Why wait until some lawyer or farmer who doesn't know steel from cast iron or who wouldn't recognize an oxy-acetylene flame if he met it, draws a bill and has it made into a law, which would absolutely prohibit welding, irrespective of how or when or by whom it is executed? There isn't a bit of use in trying to hold these things secret. A disease can't be cured by ignoring it.

Just how well equipped is the oxy-acetylene industry to present the true facts of welding? Just what data has it to offset any charges brought against it as to explosions of welded containers? We seem to be just about as well prepared as the army officers think this country is prepared to prevent invasion.

I may be accused of being a calamity howler and of thinking the oxy-acetylene industry is going to the demnition bow wows but in all seriousness these things must be considered by the industry. The fact that never in its history has it been so busy —that so many apparatus are being sold and that oxygen and carbide and dissolved acetylene manufacturers are crowded to the limit of their capacity—this does not mean that we should not look to the future and be prepared. For just as surely as the world was plunged into war when it was thought that it had grown too civilized to even consider it, so is there trouble brewing for the oxy-acetylene industry and it is directly up to the industry to prepare.

Isn't it possible to forget you make liquefacion oxygen and the other fellow electrolytic; that your filler is asbestos and the other fellow's a compound; that your torch is an equal pressure and that your competitor's is a low pressure or medium pressure; that you believe in a metal diaphragm regulator and that your business opponent uses a rubber composition? Can't the welding and cutting industry unite for a common cause, one which will benefit each and every one, forgetting for the sake of this common cause, the smaller details of competition? Other industries do it.

To promote the cause of oxy-acetylene welding and cutting, to present a solid front against unfair and prejudicial legislation, to educate, not only workmen, but engineers of other professions, requires the united effort of each and every man in the industry. No one man can do it and a few banded together cannot but if we really co-operate, we surely can.

There are two organizations which to a greater or less extent are maintained by welding and cutting interests, the Compressed Gas Manufacturers' Association and the International Acetylene Association. The first named includes carbonic gas manufacturers, ammonia manufacturers, dissolved acetylene and oxygen manufacturers, etc., but not of course others interested in acetylene generators or actual use of welding and cutting. The International Acetylene Association numbers among its members many of the larger apparatus manufacturers, both oxygen and acetylene manufacturers and also includes manufacturers of generators and fixtures for the acetylene lighting trade. For reasons well known to all of us, a considerable number of the smaller apparatus manufacturers and some gas manufacturers are not members. Can the oxy-acetylene industry get together to a point where the International Acetylene Association will embrace all—not a portion—the various interests? Perhaps it can—I hope it can—but there must be a willingness for co-operation among all—not a portion—before this can be brought about. The fact that this Association includes acetylene lighting interests mitigates against its being as powerful in the oxy-acetylene industry as I believe it should be. Taken by and large, the welding man doesn't care two hoots about the lighting and undoubtedly the lighting man feels about the same toward oxy-acetylene. Its a tough job to win any game without team play. The oxy-acetylene industry is certainly big enough to specialize in oxy-acetylene and it's my opinion, which is shared by a good many others in the industry, that it certainly needs to do so.

Whether this specialization can be brought about by the International Acetylene Association depends not only upon the International Acetylene Association itself but upon non-members as well, who have not supported it. The Association has done good things, it plans bigger things and it will undoubtedly execute these things if given the support of the entire oxy-acetylene interests—in other words if it becomes truly representative of all interests.

If the oxy-acetylene industry will not get together under the banner of the International Acetylene Association, will all the interests rally to a welding and cutting organization? Get together they must if the signs of the times are read aright.

When an industry or an organization grows to big proportions the temptation to assume that it is invulnerable is a big one in spite of the fact that there are plenty of precedents established to prove the foolishness of this view. We all remember reading how Achilles got his, that an ordinary man killed Goliath and that Rome threw out her chest to such an extent that she fell over backwards.

In later days, the Giant is killed by Public Opinion, by Legislation or Dry Rot. The oxy-acetylene industry is in no danger of Dry Rot, but Public Opinion and Legislation must certainly be considered. And what are we doing towards moulding public opinion or defending ourselves against unjust legislation—legislation regarding welding I mean, not pertaining to safety of apparatus.

Last summer I outlined a plan of co-operative welding schools. There wasn't anything particularly new about it and practically the same idea had some time previously been urged by H. S. Smith, engineer of The Prest-O-Lite Company. But the basis of the idea was co-operation and without this co-operation the plan to me did not seem feasible and does not now. Under that plan, the schools would have been operated by everyone

in the oxy-acetylene industry; no one interest could dominate; the industry would necessarily benefit; and in the industry are many men competent to push the plan to a successful point if they work together. Working as individuals, the plan is well nigh impossible to accomplish. With only a portion of the oxy-acetylene industry supporting it, the remaining portion is prejudiced, fearing that their business may be jeopardized; yet this same portion is in favor of the idea providing it has as much to say regarding the operation of the schools as the other portion. What a pity then that the entire oxy-acetylene industry cannot get together on this subject at least, when the proper growth of it so much depends upon competent workmen and this getting together means protection against unjust legislation and can be used for educational purposes other than training workmen.

As individuals or as companies, there is some work of an educational nature being done in the industry. But with the exception of one company, it cannot be said that it is far reaching in its scope or of very real help to the industry as a whole. If the oxy-acetylene industry as an industry could work as does The Prest-O-Lite Company, how quickly would any fear of unjust legislation, or lack of knowledge of the process, be dissipated? Realize what we, as an industry, could accomplish, if we were all banded together, and worked as does this company in giving aid to anyone who asked for it, of supporting our trades papers, of National advertising, of reprinting from the technical or trade press articles pertaining to welding and cutting and of taking the trouble to have a personal call made simply to start the user of an oxy-acetylene equipment on the right path.

It's the spirit of this organization that is badly needed by the oxy-acetylene industry. The growth of The Pres-O-Lite Company is conclusive evidence that this is a winning spirit.

Come on, let's talk about these things and call a spade a spade. Let's discuss openly the things which we all are thinking about and let's earnestly try to live up to our preaching, making of ourselves a homogenous body, a truly welded together organization.

## CARE IN PREHEATING.

Editor: I believe if all the welders in the country would put their different experiences down in writing in your magazine, it would help the welding business more than anything which can be done at the present time. Every day there is some job of welding ruined and a lot of money lost because the welder was not experienced enough to do the job correctly. Not long ago I was called into a garage to pass my opinon on a six-cylinder block. The water jacket on one side had been welded. The weld looked all right, but one of the middle cylinders was oblong to the extent of $\frac{1}{8}$ of an inch and the piston would not fit. The garage man could not figure out how one cylinder could warp out of shape and not affect the others.

I had not seen this particular job welded, but as near as I could figure it out, the cylinder block was not preheated and cooled properly. I have welded quite a few cylinders and I have not had one out of shape. The method I use is: Preheat cylinders to a red heat on both sides, spread charcoal in such a way that it will heat evenly all over. After cylinders are welded, allow them to cool with the charcoal fire covering with sheet asbestos.

G. A. Raguse.

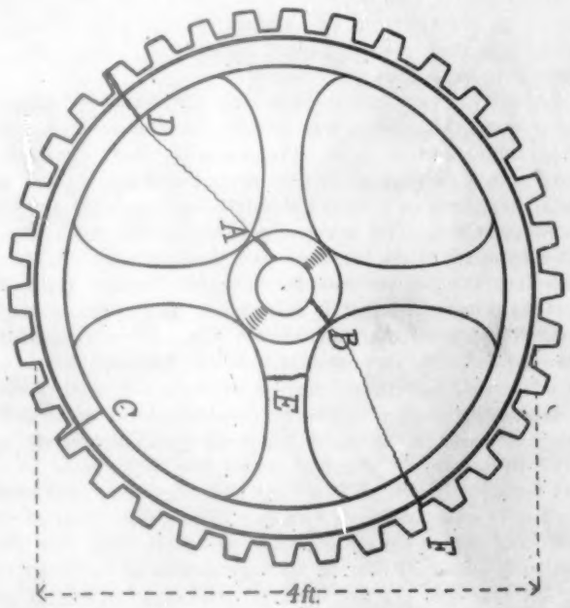
Answer: Heating a six-cylinder en-bloc casting to weld one of the middle cylinders without warping does indeed call for the utmost care in preheating and Mr. Raguse's method of studying the casting with reference to placing the charcoal to heat evenly is to be commended. There is no particular skill required in the welding of cast iron; there is a lot of care required, however, in the proper preparing to make the weld successful.—Editor.

## WELDING A GEAR WHEEL.

Editor: In the December issue you published a sketch of a four-foot gear wheel welded by W. B. Manning. His method of welding this gear was evidently successful but that his method will be helpful to brother welders I very much doubt.

In the first place, "Clamping down good and tight" on the welding table is bad policy. All the clamps in the world won't prevent the gear moving under heat; yet the use of clamps "good and tight" is very likely to lead the neophyte to believe that it will.

A more universally successful way of welding this gear would have been to first weld the two breaks in the hub, tacking them first if desired and using charcoal or other preheating agencies to save gas. After waiting until these two welds cooled down, the break in the spoke marked E. should have been welded. The reason for this procedure will be evident if it is remembered that the rim is open at three points and that expansion caused by heating the




hub and spoke has an opportunity to take place naturally and without causing any internal strains as would be the case if the rim is first welded.

After the spoke at E has cooled the breaks in the rim marked D, C and F may be welded, heating the rim slightly at these points. Mr. Manning's method of heating the rim and hub after making all the welds except the spoke E is open to much criticism, as it was wholly unnecessary to heat the hub to make this weld; heating a section of the rim around the spoke would have been sufficient to open the break at E and this method would not throw any strains upon the spokes as does Mr. Manning's method of heating the rim and the hub at the same time.

F. C. Sanborn.

## MEN WHO KNOW.

It is a noteworthy fact that it is difficult to find a welder who will claim to possess sufficient knowledge of welding. The better welder he is, we have observed, the more inclined he is to disclaim to be an expert. Go into one of the very large welding shops, where a great variety of difficult work is handled, and you will usually find the man in charge to be very modest.

# REFRIGERATION MEN TALK WELDING

## *Advantages and Disadvantages of Welding is Discussed at Annual Meeting of American Society of Refrigerating Engineers*

AT the twelfth annual meeting of The American Society of Refrigerating Engineers, held in New York City in December, the subject of welding was a most prominent one. This society numbers among its members practically all the builders of refrigerating machinery and many prominent refrigerating engineers.

Mr. Charles Hollup, superintendent of welding at the Vilter Manufacturing Co., of Milwaukee, Wis., large and successful users of oxy-acetylene and electric welding prepared a paper which was read by the president of the society, Mr. Vilter. The main portions of this paper follow:

"About 16 years ago, when electric resistance welding was in its infancy, this system was adapted for butt welding pipes in the manufacture of coils. A Thompson electric welder was used with a capacity up to 2-in. extra heavy pipes. This was a great improvement over the old style blacksmith lap weld made in an open fire. The uniformity of the electric weld, the short time required to do the work and the comparatively less skill necessary for the workman to successfully operate the machine was so pronounced that it appealed to the writer as the best method for doing the work at that time. A description of the machine is hardly necessary, as it is well known. The principle is of forcing an electric current of such volume through the metal to be heated that its own resistance is sufficient to bring every molecule of the section traversed by the current to the desired temperature. The hot metals are then forced together and the weld is made. The slight upsetting, due to the pressure applied, is smoothed down by a pair of tongs, the jams of which are bored out to the outside diameter of the pipe. The heated section is smoothed over by a rotary motion of the tongs.

"After a little practice, when the operator is able to determine the proper heat, a weld can be made that will allow its being bent to a return bend of reasonable center distance. The pipe coils manufactured in our plant are all tested under water with 250 lbs. air pressure and the percentage of leaks in the weld is less than one per cent. A lot of coils requiring 1,280 welds have just been finished and not a single leak was found.

"Shortly after the electric resistance welding apparatus was installed, the oxy-acetylene process of welding was introduced into this country. We conceived the idea of welding headers and such pipe joints as could be made in the shop by this process, doing away with screwed and soldered joints, which was a cumbersome method, with a large percentage of leaks after erection. Gradually, as we became more and more acquainted with the oxy-acetylene process, we found that a great variety of work in the refrigerating line could be done with it.

### Advantages of Welding

"After using this process of welding for ten years, adapting it to all kinds of work, it has been found that a joint made by it has a great advantage over screwed or riveted joints for the reason that after a weld is made and found to be tight, it will stay tight indefinitely. Such a weld will stand greater abuse in handling, shipping and erecting; is fully as safe as any other weld if properly welded, and in many instances gives longer life to the apparatus, in so far as no metal is cut away, as in cutting a thread where the thickness of the wall is reduced giving oxidation a chance to eat through in a shorter period of time.

"These same advantages result from electric arc welding. We use a 600-ampere generator at 80 volts which furnishes current for four to five men to weld with metallic electrodes or two men to weld or burn with carbon electrodes.

"In welding with the metallic electrode the current consumed varies with the size of wire used, that is from 30 amperes to 180 amperes as the size of wire and work increase. In welding with the carbon electrode the consumption of current will run up from 200 to 600 amperes and is controlled at will by the operator. The arrangement of the switchboard is such that every operator is independent from the others, no matter what power they are taking.

### Tests of Welded Joints

"It has been our practice to make tests of welded work from time to time for several reasons:

1st—To find the strength of a welded joint, so as to be able to figure safe on the construction and size of the work.

2nd—To ascertain the ability of any particular workman.

3rd—To convince the man doing certain work that he can or cannot be trusted with more responsible work.

"To find out the strength of welded joints, a dished and flanged head was welded into each end of a piece of 6-inch lapwelded pipe of standard thickness, the dishing being to the outside or convex. A ¾-inch pipe nipple was welded to the shell to admit hydraulic pressure. After raising the pressure to 3300 pounds per square inch, the lapwelded seam of the pipe opened up in the center, leaving the heads perfectly intact and also prevented the pipe from opening to the ends. This indeed is not an extraordinary case. We have samples of actual work where the lapwelded seam in the pipe opened up and the gas welded head and connections remained tight.

"In another test we welded a dished and flanged head in each end of an 8-inch lapwelded pipe but reversed the dishing to the inside or concave. This tank had been closely watched while under pressure and at 2200 pounds per square inch pressure, one head started to bulge and continued to do so until it turned completely to the outside, forming almost a perfect ball shape. Increasing the pressure, we noticed that at 3200 pounds the pipe shell started to expand in diameter until a pressure of 3700 pounds was reached, at which point the nipple, welded in to admit the pressure, started to leak so badly at the welded base that our pump could not increase the pressure. This leak, however was not due to a poor weld but to the stretching of the shell, which we found by measurement to be ½ inch. Aside from this nipple, every particle of welding was in perfect condition after the test.

"This sample was cut in two to show the homogeneity of the weld and has been admired by many interested people. It has been said that welding is not safe for pressure containers and has been used to cheapen the product. In answer to this, I would say that our aim was to improve our work. Riveted as well as screwed joints had to be continuously calked to be kept tight. As far as strength is concerned a properly made elec-

tric or oxy-acetylene weld will compare very favorably with other methods.

"In conclusion, welding has come to stay and while yet in its infancy will undoubtedly be improved and found more useful."

Mr. Hollup's paper was followed by considerable discussion, much of it unfavorable to welding. Many of the members joined in this discussion, giving their experiences with welding, and all seemed agreed on one point—that it required expert workmanship to properly execute a bond suitable for tension work.

### Defends Welding

Mr. John E. Starr, president of the Starr Engineering Co., of New York, gladdened the hearts of the oxy-acetylene men by bringing to the attention of the society some facts he had gathered pertaining to accidents in refrigerating plants. In part he said:

"I do not intend to discuss the technical features of oxy-acetylene welding but I have given some attention to it from a statistical standpoint as it seems that the question of what is likely to happen with autogenous welding is perhaps better measured than any other way by what has happened.

"I have collected and have the record of all the pressure cylinders made by six refrigerating machine manufacturers, giving size of cylinder, purpose used for and date of installation. This record runs back over a period of five years.

"The record covers 10,134 cylinders of all sizes from date of commencement of using oxy-acetylene welding to September 1st, 1916. Of these 10,134 cylinders listed there were nine failures or less than one-tenth of one per cent for the entire period and in every case the failure was caused by extraordinary over-pressure, mostly due to cylinders being entirely filled with anhydrous ammonia with no gas space and valves off the system.

"These statements of the number of cylinders and the statements as to the conditions occurring at the time of the failures are not loose general statements but are set forth in detail and are all sworn to by managers of the refrigerating plants who were in a position to swear to the particulars."

Mr. Starr compared this record with that of the record of boiler accidents in Massachusetts for the one year of 1914, showing that the boiler census of that state was estimated at 10,000 boilers and that the number of accidents was 38, or about 3.8 times more in one year than is covered by the oxy-acetylene welded cylinders in refrigerating work for a period of nearly five years.

### Electric Welding Talk

Mr. G. W. Cravens, commercial engineer of the C. & C. Electric Manufacturing Co., manufacturers of electric arc welding machines, addressed the society at considerable length, using the blackboard for sketching and lantern slides to show finished work executed with C. & C. apparatus. Mr. Cravens' talk was practical and he entered into considerable detail of the utmost interest to the manufacturers present and dwelt upon the cost and strength of electric arc welded joints as applied to refrigerating machinery.

---

## ELECTRIC ARC WELDING*

The question is frequently raised as to whether electric arc welding or oxy-acetylene welding is the better system. The answer is, that it depends entirely upon circumstances. This means that for some classes of work each will show some advantages over the other and it requires some experience to know where to draw the line. It may be stated, as a general rule, that the bigger the job the greater the advantage offered by the use of electric arc welding. This is due to the fact that the electric arc will develop a high temperature at the places to be welded much more rapidly than can be done with oxy-acetylene because the gas flame must be played over the surface to be welded for a considerable period before the article is brought up to the fusion point, whereas in the case of the electric arc the current passes from the job to the welding electrode, thereby concentrating the heat at the point to be welded. One of the numerous peculiarities of the direct current electric arc is, that about twice as much energy is liberated at the "positive terminal" or electrode than at the "negative terminal" and, therefore, the positive line from the welding apparatus is connected to the job, and the negative line connected to the electrode holder. The rapid fusion of the work due to this localizing of the heat is one of the causes of economy when using the electric arc.

For light sheet steel work up to 3/32 inch in thickness, the oxy-acetylene flame shows advantages because the heat can be reduced to prevent fusing the plates too rapidly, and for plates from 1/16 inch to ⅛ inch in thickness the electric arc and the oxy-acetylene systems are about equal in value. Above 3/16 inch, however, the electric arc when used with the metallic electrode shows advantages which become greater as the thickness of the plates increases. When welding sheets of copper, brass, aluminum, etc., the oxy-acetylene flame has generally proved preferable over the electric arc. When using the graphite electrode with the electric arc, the electric process has proven entirely successful on castings of aluminum or copper and copper alloys. For cast iron or steel, the electric arc has proven preferable, and it is possible to get welds on cast iron which will be just as soft and of the same structure as the original iron casting. In fast, cast iron can be welded with the graphite electrode, when properly done, so that it is impossible to distinguish between the welding and the original piece after the machining.

Welding with the metallic electrode and the electric arc can be done in a horizontal position, or against a vertical surface, or directly overhead with great facility, and large numbers of electric arc welding outfits are being used in tank and boiler shops, steam railroad and marine repair shops, foundries, machine shops and, in fact, all kinds of shops working on plates, castings or forgings of iron or steel, and in most cases in preference to oxy-acetylene. This is due to the fact that electric power is available practically everywhere in these days, thereby making the process very convenient. Also, on medium and large-sized work the process has been found to do work better, quicker and cheaper than it can be done by any other process. In shops manufacturing refrigerating machinery, the electric arc-welding process is being used for making tanks, receivers, coils, etc., for high pressure work, and receivers have been built which will stand pressure tests up to 8,000 pounds per square inch by using the metallic electrodes. Large numbers of structures have been built which stand tests of over 5,000 pounds per square, inch, and numerous receptacles are in continual service under pressures of from 300 to 500 pounds per square inch. When making up tanks, the joints are prepared in somewhat the same manner as for oxy-acetylene welding, by leveling the edges of the plates in order to get a space into which the filling material may be deposited. Owing to the peculiar action of the arc, the metal at the surface of the job is fused at the same time the metallic electrode is fused, with the result that liquid metal is deposited into a lath of liquid metal, thereby insuring a good homogeneous joint.

Where flanged heads are to be welded into the ends of tanks or receivers, it is possible to use a convex head on each end by slipping the flange inside of the drum and then welding around the head at the end of the drum, by filling in with the metallic electrode so as to form a good heavy fillet all the way around the head. This is a great advantage when building high pressure receptacles as a convex head will stand higher pressures than a flat or concave head. Where flat heads are necessary, they should be made of heavier stock than is used for the body and the edge of the plate should be beveled all around on the outer side so as to form a groove into which the filling

*Address by G. W. Cravens, before American Society of Refrigerating Engineers.

material may be deposited. This insures fusing both the cylinder and the head with the filling material, and tanks of this kind have been built to stand very high pressures. Where concave heads are required, the head should be pushed into the cylinder until the edge of the flange comes slightly inside the end of the cylinder, and the filling material deposited in the groove formed by the inner side of the cylinder and the end of the flange. This gives a shoulder around the inner side of the cylinder which is tied to both the cylinder and the flange and prevents the head being pushed out under pressure.

For high pressure work and for very large jobs, it is sometimes considered desirable to make lap joints instead of butt joints. This is especially important for the longitudinal or side seams, because such seams have to stand greater pressure than the girth seams of cylindrical bodies when under pressure. By making a lap joint for the side seams, and butt joints for the girth seams, a very satisfactory structure can be obtained by using electric arc welding, and in such cases the lap joint should be welded both inside and outside by filling in metal along the edges of the plates so as to tie them to the sheets. When assembling large tanks, it is more convenient to use lap joints in order that bolts can be put through the plates at intervals of from 18 to 24 inches along the joints to hold the plates in position for welding. After the joints have been welded, the bolts can be removed and the holes filled in with the metallic electrode, thereby making the tank tight. Lap joints are made by lapping the plates the same amount as would be done for a single row of rivets. In a few cases side seams have been formed with butt straps by bolting the parts together as described and then welding the two edges of the butt strap to the plates and afterwards welding the edges of the plates where they butt together. In such a case the edges of the plates should be beveled from the inside so that the bottom of the "V" comes against the butt strap. When welding this butt joint, the action of the arc and the filling material will be such as to not only tie the two plates together and form a true butt joint, but also to tie the plates to the butt straps, thereby adding considerably to the strength and value of the joint. In most cases, however, it will be sufficient to make a lap joint, and in a large percentage of cases the butt joint will be found strong enough for all practical purposes. All such work is done with the metallic electrode.

When welding pipes into tanks, it is sufficient to make a hole in the tank of approximately the same size as the pipe and then slip the pipe through the hole and weld around the joint on the outside with the metallic electrode so as to form a good heavy fillet and tie the pipe to the tank. When building up complicated sections of piping, such as for refrigerating coils, etc., where the pipes are connected to headers, the pipes can be inserted into the header the same as above described for tanks, and the heads can be welded into the headers by using flat plates which have been beveled as previously described for flat headed tanks. Where two sections of pipe are to be welded together, end to end, it is merely necessary to bevel the ends of the pipes so as to form a "V" groove on the outside and then fill in with the metallic electrode, the same as when welding sheets by forming a butt joint. Where flanges are to be welded on to ends of pipes or large sheet steel cylinders, the inner edge of the flange should be beveled all around so as to form a groove and then fill in with the metallic electrode. This work should be done on the back of the flange in order that the front surface may be left smooth for bolting up.

For the best results from electric arc welding, it is important that the current be kept within reasonable variation from the average amount required by the job, and this can readily be insured by having properly controlled apparatus on the welding circuit panels. Where several men are to work from one welding machine, it is necessary to use a constant voltage generator with individual control apparatus on each welding circuit panel so that each operator can adjust his current to suit the job in hand. Where a single circuit machine for one operator only is installed, this machine may be either of the variable voltage or constant voltage type, although the constant voltage type has found a wider range of application up to date.

Electric arc welding outfits consist of a specially constructed, low voltage, direct current generator, direct coupled to a motor of proper capacity for driving the generator under all conditions of load. These motors may be for either direct current or alternating supply circuits, as may be required, or may be gasoline or other internal explosion motors or steam engines. Where direct current is available, it is also possible to use a dynamotor, or direct current converter, and this is done by one of the manufacturers. In addiiton to the welding machine there must, of course, be a suitable control panel containing the necessary meters, switches, etc., for controlling both the motor and the generator, as well as suitable means for controlling the welding circuits. The C. & C. Electric & Manufacturing Co., Garwood, N. J., whom I have the pleasure to represent, has a patented automatic control for the welding circuits which has been developed in order to keep the current within predetermined limits while welding. When the outfit is of small capacity and arranged for a single operator only, it is customary to mount the welding circuit control apparatus on the main control panel previously mentioned. Where several men are to operate from one machine, however, it is preferable to have the control apparatus for each welding circuit on a separate panel in order that the panel can be located wherever convenient with relation to the work, without regard to the welding machine. Suitable means are provided on each welding panel for adjusting the current to suit the job in hand, and with this system each man is independent of every other man regardless of the kind of work to be done. The distribution circuit is carried from the main control panel out through the shops and the welding panels tapped into this circuit, the same as would be done with a corresponding number of motors or electric lights in the case of the usual shop distribution circuit. Each operator must be provided with a suitable face shield containing a colored glass window of proper kind for protecting face and eyes from the heat and light of the arc, and a suitable electrode holder is also necessary to carry the metallic or graphite electrode depending upon the work to be done.

The art of electric arc welding is not so well known as it should be when it is considered that welding is one of the oldest applications of electricity. Commercial electric arc welding with the graphite electrode has been done for about 30 years, and with the metallic electrode for nearly 10 years, but in spite of the advantages resulting from its use, there seem to have been, and still is, some hesitancy in adopting electric arc welding. In view of the great advantages which will result, progressive engineers and manufacturers who have had the opportunity to investigate the process have without exception adopted it for all but the lightest sheet metal work, and it is confidently expected that developments in the electric arc field during the next five years will probaby be greater than developments in any other branch of electrical engineering.

---

## CYLINDER BREAKS.

Bevel the break out with a diamond point chisel, and clean break for a distance of half an inch on each side of crack. Take off fittings, valve caps, pet cocks, springs, etc., then place head down in fire. Don't force fire, as it will take some time to heat properly.

Sometimes cracks or breaks run through threaded portions, where it may seem necessary not to touch the thread. In this case use a carbon block to plug hole. Don't use clay.

# REMINISCENCES *of a* WELDER

## *Each With a Moral—3 Curfew Shall Not Ring Tonight*

LOOKING backward over the years since I started in to learn something about welding, I am amazed to find how much we know now in comparison with what we did know but a few years ago. Of course, we have really just begun even now to learn and the future will show uses of welding not thought of at this time; in other words, we have simply scratched the surface of possibilities of this wonderful process. Education of the operator goes hand in hand with new developments. But if we are just starting to learn now, I wonder just what our education consisted of in the earlier days!

Of course, our mistakes sound foolish to the well-trained man of today, but they were not foolish to us then. We had no text books, no trade papers, no way whatsoever of getting information except through our mistakes. They say that only fools learn by experience, but it was necessary evidently that we simply had to be fools, for there was no opportunity to learn by the other fellow's mistakes. Times have changed and today the reader of the trade paper may avoid these mistakes by reading about them instead of undergoing them—and this method I can assure you is much the cheaper.

Yet I would not have had it otherwise. I am so constituted that I have to be shown and those costly errors of earlier days of welding drove home to me basic facts which never will be forgotten. If I could only have learned them without having paid so much, the experience perhaps would taste a little sweeter, but having paid, I'm glad. You who read *The Welding Engineer* now buy for a couple of dollars in the way of a year's subscription that which formerly cost a couple of thousand and perhaps more.

And now for the plot. Unlike the two preceding reminiscences, I was not mixed up in this error of judgment, the sole reason being my absence from the city and not because of any superior knowledge. In a village about 25 miles out, the town bell had become cracked. It wasn't a very big crack—perhaps five or six inches or so—but it precluded the ringing of the bell so the local fire department was up in the air, the school kiddies didn't know whether they should attend sessions or not on a stormy day and the nine o'clock Curfew law was for the time being a dead letter.

The selectmen of the town decided upon a new bell, but the local garage man, having been one of those rare birds, a successful patron of our shop, put us in touch with the town fathers and our foreman went out for the usual price dicker. (Be it explained that in those days, we invariably made quotations to avoid the embarrassment of charging a man around $25 an hour on an itemized bill. If he was satisfied with the price quoted before his work was done, it didn't give him much of an opportunity to yell if he happened to know how long it took. Of course, he couldn't understand that he must pay for failures of other work and we could hardly explain these things to him; hence the rule for quotations.)

Now that particular belfrey housing that particular cracked bell was so constructed that taking the bell down would have been a terrific job and a costly one, so after casually looking the bell over, the foreman decided that it could be welded "in situ" as we were fond of saying, meaning that it could be welded in place without dismantling. A price of $150 was agreed upon, we to guarantee the bell would ring, but being careful not to guarantee the original tone and, of course, the selectmen were to hold us harmless if we did not succeed, but they in this case were to pay us nothing.

A couple of mornings later the auto truck started on its 25-mile jaunt, carrying two equipments, four men, *steel welding rods*, and, of course, all the essentials to prepare, weld and finish; that is, the crew thought they had the essentials. The first surprise came when the break refused to respond to the action of the cutting torch which was to be used for beveling or grooving out the metal. Up to this time, no one had taken the trouble to find out what metal was used in bell construction and it had been taken for granted that it was wrought iron or mild steel. But when the break was chiseled into it was found that it was not iron, but a metal quite brittle, since it broke out in chunks rather than in chips and the color was grey or perhaps rather "whitish." It certainly was not brass and it didn't look like any composition bronze which had ever been welded in the shop. That day was spent by the four men in beveling the break and studying just how the weld should be made.

The next day only three men went out, this time carrying Tobin bronze welding rods and after getting the gas tanks up, little time was lost in getting started . The break ran to the edge and on the apparently valuable suggestion of one welder, the bell was tipped so that the crack would be on an angle considerably nearer horizontal than it was when in its natural position. As the bell was tipped, however, it became necessary for the welder to take a position rather precarious, half in and half out of the belfrey so when all was ready, the two other men hung on to the third in order to keep him from falling.

I wonder if the welder, as he lighted his torch, thought of the school-boy poem:

> "Out, far out, she (or he) swung
> Till the city seemed a tiny speck below."

Whether he did or didn't, his mind was somewhere else than on his job for he began the weld on the edge and started to work toward the top of the bell. He had progressed about an inch when the crack lengthened a couple and as well, the weld he had just made opened up. This made it necessary to again chisel out the metal which had been added and again the weld was started as before and with about the same results; but this time smaller cracks appeared, running into the break at various angles.

That day was done, so back to the shop came the men, tired and discouraged and each one cussing that peculiar metal. The foreman decided upon an analysis of one of the chunks which had been chiseled out and at a cost of $25 learned that it was bell-metal and that this particular sample was about three parts copper and one part tin. A local foundryman cast the same metal in the form of welding rods at a stiff price and with fresh courage born by the removal of uncertanity as to what the metal was, the srew went back to the job. Another day's work with the new welding rod didn't improve the bell any and that day ended

with the crack ten or twelve inches long and quite a large number of little tributaries running into it.

By this time it had dawned upon the welders that the extension of the old crack and the addition of many new ones was caused by contraction so an oil torch and considerable asbestos was added to the equipment and preparations made to preheat. Can you picture that crew in a wooden belfrey, the wind howling through it, trying to preheat a bell with a powerful oil torch hot enough to prevent contraction cracks, but with no fire bricks and no way of using them if they had them? Can you realize the difficulties of keeping "the old tower" from burning up and the burns all of them received when tipping the bell?

Of course they didn't succeed. New cracks appeared under the heat of the oil torch, but that crew didn't give up for a couple of days and when they did, the bell was hopeless, but they had learned something—they knew what bell metal was and they had had a lesson in expansion and contraction which stuck. Incidentally, the lesson "stuck" me their wages, a goodly number cubic feet of gas, I don't know how many pounds of welding rods and the wear and tear and gasoline for the auto truck used in the voyage of discovery. But we all learned the

*Moral: An Ounce of Consideration is Worth a Pound of Second Guesses.*

Next Month—That Cast Iron Connecting Rod.

## PREHEATING REO CYLINDERS.

Editor: I had two cracked cylinders (Reo), to weld. I welded one all right, but the other one I had to weld five times. I preheated slowly in a charcoal fire for about four hours, starting with the cylinders standing up, as they would be in use. I built a light fire under them and gradually increased the heat, until they were very nearly a shade of red, hardly noticeable. I welded them and put them back in the fire and left them until next morning. I cleaned up the weld and filled up with water and while looking for a leak they cracked crosswise of the weld, or rather parallel with the cylinder. After welding them again they did the same thing, only with two more cracks in another place. —George M. Hamilton.

Answer: The fact that you welded one pair and the other pair cracked while being tested under pressure simply proves that you were at fault somewhere in preheating.

We would criticise your method of standing the cylinders up in the position they normally occupy and then banking charcoal around them. There isn't the slightest need of preheating the cylinder walls below the water jacket, as this method will do, and this invites tension strains which are hard to overcome.

Slow heating, such as you describe, is the proper method of heating cylinders, but we doubt the value of a closed box for preheating. We would rather use a forge with charcoal, or an open pan of some kind, covering with asbestos paper; or use a temporary fire brick furnace. While charcoal will burn with little air, you can more quickly and without danger have some air to aid its combustion. Additionally, the fact that you must remove the cylinders from the box, make the weld, and then put them back again, allows the cylinders to cool considerably while you are making the weld, and this would be one reason for possible failure. Much better make the weld while the cylinders are in the fire, which you can easily do if you do not use a closed box for preheating; and keep the cylinders protected with asbestos paper with the exception of that portion you are welding.

It is necessary to study each kind of cylinders to ascertain where those parts are which require the most heat Around the valve chamber for instance is heavy metal and if the break runs close to it, it will be necessary to give the valve chamber considerably more heat than other portions; this you can do by banking more charcoal around that section.

Get hold of the principle of expansion and contraction—and individual cases will come easy. We would advise that you purchase a book on welding which gives this principle. —Editor.

## PREHEATING ALUMINUM.

Editor: We note in your November issue, page 29, an article by C. K. Armstrong. Will you kindly advise whether it is necessary to cover the entire casting with asbestos and plaster paris he speaks of, to weld a slight shrink crack, and also whether he preheats the entire job with a blow torch. —Werra Aluminum Foundry Co.

Answer: Mr. Armstrong in reply to this question states: "If this man has never had any experience on aluminum welding he had better not start in on an expensive case. The best explanation I can make in writing is to advise putting in enough asbestos and plaster paris to anchor it firmly, as after it is dry it falls out very easily. Relative to preheating would say this depends on where the crack is. If on an engine base the crack is through where the oil pan bolts on, it is not necessary to preheat, but if crack is up where cylinders bolt on, it would have to be preheated. But great care must be taken in preheating aluminum, as it will not support its own weight when hot. I very seldom preheat aluminum on this account, as you can get away from this by sawing from the edge down to the crack, but if you don't know how to do it right it will warp. Spread the case open by driving in a wedge and when you get almost down knock the wedge out, as without the wedge it will close and throw it out of line. Also mould must be dry before starting to weld, using flux as for cast iron. If it is the right flux it will flow together and make a perfect joint. After case is cold flux must be washed off with water, as it has a corroding effect."

## THE SCHOOL QUESTION.

Editor: There are three welding shops in San Francisco turning out student welders. Two of these schools charge $50 for three days' instruction and the other charges $35 for 50 hours actual torch practice. At present five good welders are walking the streets on this account.—Frank Adams, care of Moose Club, San Francisco.

Editor's Comment: The welding school subject is a much discussed topic. There are good ones and there are many poor ones. Poor student welders damage the cause of welding. Perhaps some western reader can place Mr. Adams, if he wants a position.

## DEVELOPMENT IN RAILROAD FIELD.

For many years electric railroads have been applying copper rail bonds by the oxy-acetylene method. Only recently has it been discovered that iron, or mild steel bonds, may be welded on to rails and replace the bothersome wire bonds now in use for block signals. The new bond is not only more durable and cheaper, but it is also more efficient.

# THE EFFICIENCY *of* ARC WELDING

## *Value of Welding is on Trial Before Boiler Code Committee. Paper Read by Mr. P. A. C. Armstrong*

On December 9 and 10, the Boiler Code Committee of The American Society of Mechanical Engineers held a public hearing at the Engineers Building, 29 W. Thirty-ninth street, New York City, on proposed changes in the Boiler Code. Representatives of a number of welding interests were present and presented facts and arguments supporting a plea to revise Rules 186 and 187 to permit the use of autogenous welding in the manufacture and repair of boilers.

The Boiler Code Committee is made up of the following members: J. A. Stevens, chairman, Wm. H. Boehm, R. C. Carpenter, F. H. Clark, F. W. Dean, J. E. Durbam, C. Ferrari, E. C. Fisher, C. E. Gorton, A. M. Greene, Richard Hammond, A. L. Humphrey, C. F. Hughston, D. S. Jacobus, S. F. Jeter, W. F. Kiesel, W. F. MacGregor, Ed. F. Miller, M. S. Moore, I. E. Moultrop, R. D. Reed, H. G. Stott, H. H. Vaughan, and C. W. Obert, secretary.

The welding interests were represented by: P. A. C. Armstrong, Quasi-Arc Weldtrode Co.; Robt. E. Kinkead, Lincoln Electric Co.; C. A. Wildt, Lackawanna Boiler & Grate Co.; Victor Mauch, John Wood Mfg. Co.; Mr. A. L. McCabe, the Davis-Bournonville Co.

The importance of the results obtained by this movement to get recognition for the autogenous welding processes can hardly be over-estimated, since favorable action by the Boiler Code Committee will open up a new field of welding for both the electric arc and oxy-acetylene welding processes. Boiler manufacturers as well as commercial welders will find an extensive field in the welding of stationary boilers that has heretofore remained untouched, owing to the lack of recognition of autogenous welding by this Committee.

The work of the Boiler Code Committee is published in the form of "Rules for the Construction of Stationary Boilers and for Allowable Working Pressures." These rules do not apply to boilers which are subject to federal inspection and control, including marine boilers, boilers of steam locomotives and other self-propelled railroad apparatus.

The Boiler Code serves as a guide to manufacturers of boilers and pressure vessels, insurance boards, state legislation and is recognized as the standard of minimum requirements for boiler and pressure tank construction in this country.

The advocates of electric arc and oxy-acetylene welding based their claim to recognition and therefore revision of Rules 186 and 187 on the general points given below. These rules read as follows:

Rule 186. The ultimate tensile strength of a longitudinal joint which has been properly welded by the forging process, shall be taken as 28,000 lbs. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lbs. per sq. in.

Rule 187. Longitudinal Joints. The longitudinal joints of a shell or drum which exceeds 36 in. in diameter, shall be of butt and double strap construction.

1. The demand for large high pressure drums has reached the point where the thickness of the metal required to withstand the pressure is too great to be riveted owing to the excessive thickness of the metal obtained in the joint and the consequent difficulties encountered in exposing such a joint to the fire. The obsolete forge welding process does not offer a solution to this problem because of the unreliability of welds and the impractibility of welding vessels of such size in this manner. The autogenous welding processes offer a reliable and entirely practicable means of welding such vessels regardless of the thickness of the plate or size of drum.

2. In the field not covered by the code (Marine and Locomotive Boilers) the utility of the autogenous welding processes has been recognized by the U. S. Bureau of Steamboat Inspection and the Railroads and extensive work has been carried on in this field. A large amount of data is available on the work of this class which has been accomplished and the fact that the amount of work being done is rapidly increasing is an indication of the fact that it is successful.

3. The autogenous welding processes are being used extensively in all kinds of high pressure vessels as distinguished from steam boilers evidence of the success of which application is readily available and further that in with-holding recognition of the processes, the Boiler Code Committee is, by inference, discriminating against a successful development in boilershop practice. (Testimony was offered on this point by a manufacturer of such vessels who has more than 2,500,000 of such vessels in service to show that the percentage of failures on welded vessels is actually lower than on riveted vessels. The period covered by this manufacturer's experience is fifteen years and both electric arc and oxy-acetylene processes were used.)

4. The recent improvements in the art of welding in the apparatus and in methods of testing the product, notably in the electric arc process have made it possible to make welded joints which are stronger and more reliable than riveted joints and that the formerly accepted idea that the welded joint is an "unknown quantity" has been disproved by present day practice. (In this connection, photo-micrographs were shown, proving that the thermal disturbance in the metal adjacent to the weld is negligible in the arc process and that the crystalline structure of the metal in the weld is that of normal cast steel. Owing to the use of an improved slag covered electrode, perfect diffusion of the metal added is obtained and oxides which produce "cold-shortness" are eliminated. Samples were submitted which had been welded with the slag covered electrode and a constant heat variable voltage machine, which showed in equal section greater strength than the original plate as well as the ability to stand a cold bend of 180 deg. through the weld without fracture. It was claimed that a welded joint of this kind is superior to any riveted joint because it is at least 20 per cent stronger and possesses elasticity, which is a property which cannot be obtained in a riveted joint.)

5. An autogenously welded joint is superior to a forge welded or riveted joint for boiler seams, owing to the fact that in the older methods, the impossibility of uniform mechanical treatment of the metal produces local areas of metal in the weld which are electro-positive to the unaffected areas, thereby setting up electrolytic action and corrosion by a precipitation of the soluble impurities in the water. It was claimed that the improved slag covered electrode used in the electric arc process deposited metal which is always electro-negative,

and that, therefore, corrosion from this source is entirely eliminated.

6. The use of the autogenous welding processes is very desirable from the economic point of view, since the cost of manufacture can be reduced considerably thereby, and the cost of maintenance decreased materially.

7. The completely welded boiler is entirely practicable and the Committee was invited to observe the performance of a 125 H. P. unit built by the Lackawanna Boiler & Grate Co. and in service at the present time.

The thoroughness and deliberation which characterizes the action of the Boiler Code Committee make it probable that a final decision in the matter will not be published for several months.

## THE EFFICIENCY OF ARC WELDING.*

The efficiency of a welded joint must be determined not only by its tensile strength, but also by a consideration of the nature of the changes introduced by welding in the structure of the metal and its most desirable feature—ductility.

The essential characteristics of a satisfactory fusion weld are:

First.—That the metal in the welded joint shall be pure and free from all trace of iron oxide.

Second.—That the welding process employed shall be such as to reduce to a minimum the thermal disturbance to the structure of the surrounding metal.

Third.—The manual dexterity required in the operation of welding should be eliminated as far as possible.

The superiority of electric welding over gas or fire welding is due to the extremely localized character of the heat generated by the electric arc, thereby resulting in a smaller area of thermal disturbance.

The gas welding process has the effect of setting up considerable thermal disturbance in the vicinity of the weld, also it is very difficult to arrange the flame so that it is neutral. In practice, unless very expertly handled, it is generally oxidizing or carbonizing.

If oxidizing, the metal in the weld becomes cold-short and the weld generally very imperfect—an oxidized layer being present at the junction between the added and original metals.

If carbonizing, the weld will be found very hard, full of small cracks and having a number of gas holes due to the oxygen in the atmosphere combining with the carbon and forming gas.

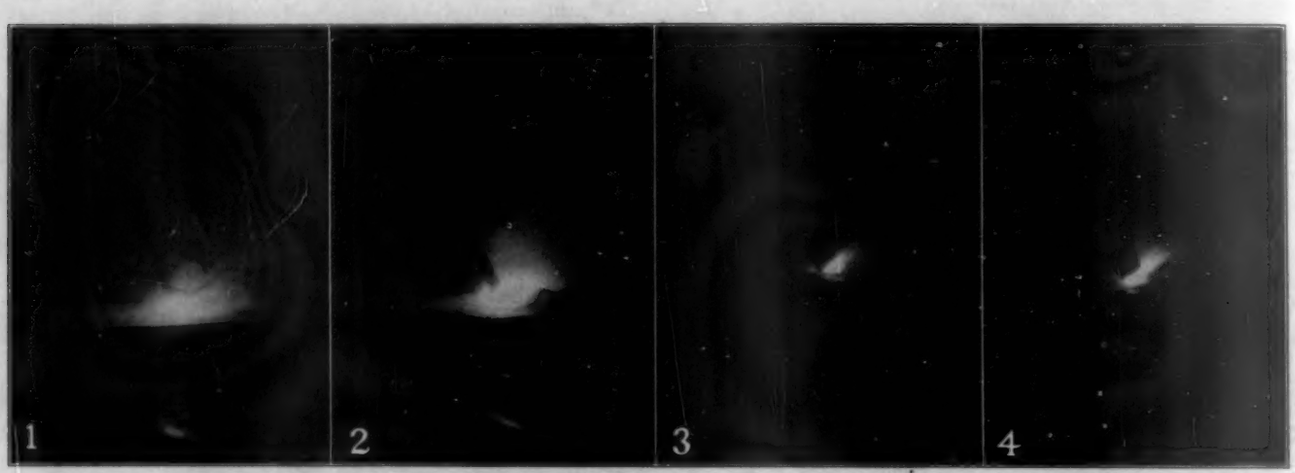
Welding by the means of this process can be very satisfactory if the flame can be made neutral and kept so and the welding metal added to the work in very small quantities.

Its practical application in the shops, however, does not lend itself very well to the attainment of this ideal condition and the average weld has patches of iron oxide between the added metal and the original plate.

The original metal is overheated and the structure materially changed, resulting in the well known fact—reduced tensile strength in the vicinity of the weld.

The electric carbon arc process has a tendency to heat the area around the weld almost as much as the oxy-acetylene process, and the metal deposited contains magnetic oxide of iron, practically structureless, being both cold and hot-short—the fusion between the added metal and the original metal is distinctly imperfect, and as everyone is doubtless aware, many instances have occurred where the entire added portion of the metal has become detached from the weld. Furthermore, a very high grade of skill is required for the proper manipulation of the arc.

The bare wire electric arc process overcomes some of these difficulties. The thermal disturbance in the vicinity of the weld is to a very large degree restricted as compared with the two former processes, but the deposited metal is usually oxidized and distinctly cold-short, therefore having almost a complete absence of ductility.




Figs. 1 and 2. Bare Wire Arc in Operation. Figs. 3 and 4. Lansic-Arc Slag-Covered Electrode in Operation.

To weld iron and steel satisfactorily the conditions present during manufacture must be duplicated; otherwise a metal of like structure is an impossibility.

Every steel manufacturer knows to his cost that a melt is quite useless unless it is covered during the entire period of its molten state with a very large body of slag, the duty of this slag being to exclude atmospheric influences and to create certain chemical reactions and conditions in the bath.

It is a matter beyond dispute that the modern-day alloyed steels are due largely, if not entirely, to the improvements in slags and the resultant ability to maintain in the melt the alloys desired; therefore the slag is the crux of the situation.

The electric steel furnace has helped in the manufacture of alloyed steels, due to the extreme control of the heat, the known constituents of the flame, the heat value of the arc and the better protection of the melt from atmospheric influence. Incidentally the arc resistance furnace can be regarded as the best commercial furnace.

To weld satisfactorily it is necessary that these highly essential melting conditions are maintained. Naturally they must be in miniature.

The bare wire metallic electrode or carbon arc are very similar in some respects to the electric steel furnace, but the great difference is one of the essential features, namely, slag.

If the bare wire electric arc could be so arranged that the fusion could at all times take place under a large body of cor-

*A paper read by Mr. P. A. C. Armstrong at the hearing of the Boiler Code Committee of the A. S. M. E., at the Engineers' Building, New York City, December 8-9.

rectly constituted slag, then the resultant molten metal would have all the characteristics of ingot steel.

There has been developed and largely employed during the past four years in Great Britain an electrode which has all the aforementioned essentials; in fact, the weld produced by its use is practically miniature steel bath welding.

This special electrode is composed of an iron or steel core (according to the metal desired to be deposited); running parallel to its axis is a very thin aluminum wire—its purpose being to purify and quiet the metal—and covered its entire length by a braided slag, the object of this slag being to duplicate in miniature the conditions present in the electric steel furnace.

The metallic core of this new electrode is placed in an open electric circuit of either alternating current, 60-cycle, up to about 100 volts, or direct current at about the same voltage.

The slagged end of the electrode is brought in contact with the job to be welded and an arc is formed which has the effect of fusing the core and the covering slag; the atmospheric vapor arc is immediately extinguished and a quasi-arc of vaporous slag takes its place. This peculiar form of arc has a higher resistance than the ordinary atmosphere vapor arc and does not have to such an extent the same highly oxidizing influence.

The molten metal flows out from the end of the electrode on to the work and is at all times covered with a large body of slag.

The munual dexterity necessary for the accomplishment of a perfect weld is reduced to a minimum. This is best appreciated by the fact that this type of electrode can be used automatically.

One end of the electrode is brought in contact with the job, an arc started and the fusion immediately takes place until the entire electrode is consumed. The reason for this is that as the slag is of highly refractory material, the exterior of the slag of the electrode rests upon the job to be welded and is not fused very readily by the peculiar type of arc present. A given distance can be maintained between the fusing end of the metallic core of the electrode and the work.

The slag has the effect of making the heat extremely local and insuring the complete fusion of all metal within its vicinity. The fusion takes place under a protective covering of slag and is not exposed to harmful oxidizing influences of the atmosphere. All the molten metals become thoroughly mixed together, a complete diffusion taking place.

It is practically impossible to get an indifferent weld when the current conditions are such as will allow for the complete fusion of the metals in the immediate vicinity of the fusing end of the electrode.

There is no tendency for the slag to become entangled with the weld as it is much lighter than metal and has no affinity for same—therefore it floats freely upon the surface of the molten metal.

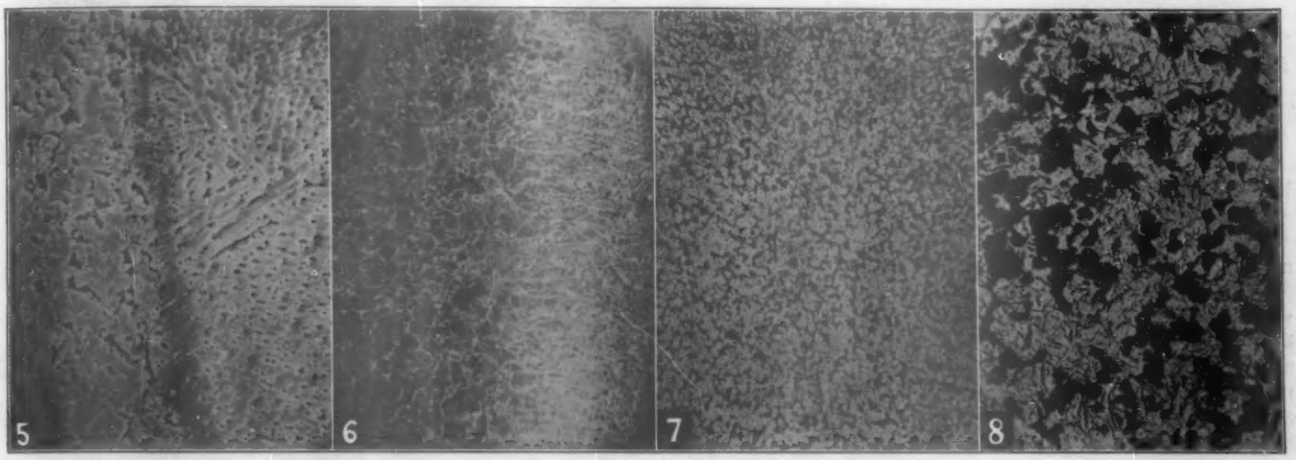
Figs. 1 and 2 are photos of the bare wire arc in operation.

Figs. 3 and 4 are photos of the quasi-arc slag-covered electrode in operation.

To demonstrate and prove how perfect is the diffusion of the metals deposited by this system, a slide (Fig. 5) will be shown depicting manganese steel of about 12 per cent content deposited by this electrode upon manganese steel of a like content. The photo-micrographs were made by Prof. William Campbell of the School of Mines, Columbia University, New York City. As will be readily seen, the deposited metal is quite as good as the original manganese steel, although the structure, due to the added metal being cast, is different from the original manganese steel which has been forged.

Fig. 6 is a photo-micrograph X60 of mild steel deposited upon higher carbon steel by the slagged electrode. The added metal is of excellent structure and about .125 carbon. The area of diffusion is good and saturation of the carbon has taken place at the weld.

Fig 7 is a photo-micrograph of the mild steel deposited by the slagged electrode. The carbon is about .125 per cent, the grain is small, showing consistently arranged patches of pearlite and ferrite—a very excellent steel.




**Figs. 5, 6, 7 and 8. See Right-Hand Column, This Page.**

Fig. 8 is a photo-micrograph X430 of metal deposited by the slagged electrode. The carbon is about .6 per cent; the sample has been heat-treated and shows Martensite and Troostite. The metal is excellent.

Much emphasis has been laid upon the elongation of welded sample pieces, but conclusions drawn from tests are generally erroneous as the elongation does not occur in the weld but in the metal outside the weld.

No elongation tests of welded joints can be considered unless the measurement for elongation is taken over the actual welded area. It will be found, generally speaking, that if this system is adopted, the usual welded joint will show something less than ¼ of 1 per cent.

The tensile strength of the weld also has nothing at all to do with the usefulness of the weld. It is a well known metallurgical fact that steel containing high percentage magnetic oxide of iron, that has been overheated and burnt, will actually give a higher tensile load than steel, of the same carbon content, which is commercially free from oxide and has not been spoiled by any excessive heat-treatment; but the ductility of these metals is entirely different. The first being cold-short and having a decided absence of ductility, the latter, although having a lower tensile strength, has a very high ductility.

In view of the importance which the subject of corrosion bears to that of welding, it will be well to point out that fundamentally corrosion is electrolytic in character and depends on the difference in potential of continguous areas.

Commercial iron or steel contains areas which in the presence of an electrolyte (which may be merely atmospheric moisture) are capable of forming voltaic circuits, the necessary conditions being afforded by the presence of small particles of impurities or by local conditions of strain in the metal itself.

These impurities or strains give rise to areas of higher electrolytic potential and form the electro-positive points which are first attacked by the corroding agent. Thus, in a caulked joint corrosion begins at the caulking, and similarly a riveted joint will be attacked around the rivet head, owing to the local strains in the metal at these points.

In a welded joint if the metal at the weld be less pure than the surrounding metal, the weld will be first attacked. Similarly, if the added metal be not homegeneous, local differences in potential in the weld itself will cause corrosion at the weld.

A microscopic examination of the metal deposited by the special slagged electrode shows it to be of extraordinary purity, and it will be found by the usual laboratory test to be always electro-negative to the surrounding metal. Hence, it follows that a weld thus made is not so subjected to corrosion.

From the facts I have laid before you it is quite evident that boilers can be satisfactorily welded without the possibility of failure resulting from

First.—The absence of manual dexterity.

Second.—The failure due to imperfect weld.

Third.—The failure due to oxided metal.

Fourth.—The harmful thermal disturbance in the surrounding metal.

Fifth.—Corrosion due to electrolysis.

These possibilities of failure can be entirely overcome and never need be present.

As an instance of the strength possible in welded pressure vessels, i. e., boilers, the British Admiralty and War Office (who have adopted this special electrode almost as standard practice) are welding the cases of sea mines, in preference to riveting them, also the canisters of bombs, it having been found that the joint thus welded will give a higher bursting charge than can be obtained from any triple or quadruple riveted joint.

Another interesting application is the welding of hand bombs which have to stand about 4,000 pounds pressure before bursting. These are made of nickle chrome stampings in two halves and welded round the periphery by one of these special electrodes.

---

## DISCUSSION AT HEARING OF COMMITTEE.

P. A. E. Armstrong: I do not think that the forge process of welding is the only process that is valuable for boiler work. The forge process of welding is not as reliable as could be desired—not from the point of a bad weld as from the difficulties present by thermal disturbance in the metal in the vicinity of the weld. The thermal-disturbed area of the weld itself is somewhat recovered by the mechanical treatment it is subjected to.. The thermal-disturbance is brought about by two things—time and heat—both playing a very important part in welding. The disturbance to the steel in the vicinity of the weld is such that the grain is enlarged and the tensile strength of the metal has fallen about one-third. I have conducted a series of tests on welds, something over a thousand, in working up a high class steel suitable for welding—these tests being conducted in Sheffield, England—and I found that with ordinary 30 to 40 carbon steel it was impossible to get more than about 60 per cent of the original strength, yet the breaks did not occur in the weld but some two or three inches away from the hammered area. In every instance the break occurred because of an enlarged grain.

It is true that the crystal grain of the metal (providing the thermal disturbance has not been to the point of incipient fusion) can be brought back, that is to say, can be recovered by subsequent heat-treatment; but this is hardly applicable for boiler work; and I think it is absurd to talk of annealing the shell of a boiler at least 30 ft. in length. It is not unreasonable to suppose this shell, after being welded, and when annealed, would expand and buckle in all sorts of directions, causing lumps, distorted plates, etc., which would be quite impossible to get out. Further, if this boiler had riveted joints the expansion and contraction due to annealing would be so great that a movement would be set up at the riveted joint, and all the caulking in the world would never give a tight joint, but in all probability would augment the looseness of the rivets.

It would be as well to review the situation from the point of thermal disturbance in fusion welding. The oxy-acetylene or gas process generally is a very good one, but the thermal disturbance in the metal outside the weld is very similar to that present during forge welding. The electric carbon arc welding is worse. The electric bar wire welding, known as the metallic pencil welding, overcomes thermal disturbance to a greater degree, but the deposited metal in the weld is distinctly "cold-short." This "cold-shortness" could be improved by annealing; but, as aforementioned, this is quite impossible under boiler conditions.

I have a few photo-micrographs with me which I would like to throw on the screen because I want to show you that it is possible to have a fusion process where the fused metal has a structure which is practically as good as the original steel. This is only possible by duplicating steel bath conditions.

If you take a bare wire electrode and coat it with a large quantity of slag, it is possible to melt this electrode so that the fusion takes place under the slage and the deposited metal would have all the characteristics of ingot steel of a given carbon content. Such an electrode has been developed and is extremely suitable for the welding of boilers and pressure tanks generally. The exterior slag coating of this electrode, when being fused by the electric current, has the effect of making the heat very restricted and extremely local. The metallic core of the electrode is fused so rapidly, and the area of the original metal is brought to a point of fusion with such speed, that there is practically no thermal disturbance in the vicinity of the weld and complete fusion takes place. The working of this electrode in comparison with the bare wire system I will throw upon the screen; also photo-micrographs showing the thermal disturbance due to gas welding and the absence of serious thermal disturbance by the welding with the slag-type of electrode.

Mr. Chairman, may I show the photomicographs on the screen?

The Chairman: I think you might put those on the screen, and I think it would be for the benefit of all.

P. A. E. Armstrong: The first four photographs I desire to show you arc photographs of the arc in operation. The photographer said that it was quite an impossible job to make such a photograph, but this was overcome, and I think I might safely say that these are the first photographs of an arc in operation which have been shown in this country.

Slide No. 1 shows the bare wire electrode in use—taken with a light screen. It will be seen that there is a globule of molten metal falling off the end of the electrode and is passing across the arc to be deposited on the steel to be welded. The arc flame is very large and is subjecting the deposited metal to the harmful effects of the arc flame.

Slide No. 2 shows this much more clearly. This photograph was taken with a darker screen and the globule of metal is just leaving the end of the electrode, to be passed across the arc and deposited upon the metal to be welded. The flame or highly incandescent gases immediately underneath the electrode; that is, the shortest distance between the end of the electrode and the work, are very nearly neutral and the outside of the arc flame the burning gases are extremely oxidizing. It is here that the damage takes place. A very interesting experiment can be conducted to prove the harmful nature of the

outside of the arc flame. If a bare wire electrode is fused a crater is formed immediately beneath the fusing end of the electrode. If the circuit is broken by the switch being pulled on the machine, the arc is immediately extinguished; at the bottom of the crater there is a complete absence of oxide of iron, whereas on the top edge of the crater and right over the deposit a layer of about 1/100 inch of oxide of iron is present. This proves that in the center of the metallic arc there is a neutral place. If this flame is examined by the means of the spectroscope the oxidizing nature of the arc flame can be very quickly traced and the whole neutral zone can be discerned in the center of the flame when the outside of the arc flame gets slightly disturbed.

Slide No. 3 shows the slag electrode in operation. It will be seen that the end of the electrode is in actual contact with the job—different from the bare wire—in which case there is a space of about 1/8 inch between the fusing end of the electrode and the work. As will be readily seen, there is a complete absence of the arc flame effect, and the incandescent slag is passing off from the end of the electrode onto the work.

Slide No. 4 shows this operation in a little more detail.

The atmosphere of the Quasi Arc slag electrode is practically neutral as the vapor is composed of vaporized slag and not highly incandescent atmospheric gases. The voltage across the arc is higher than the voltage across the arc of the bare wire system. This is because the vapor offers a greater resistance to the path of the current, although the arc is shorter and should take only about half the volts to get across, if the arcs in both instances were atmospheric.

Corrosion and welding are closely associated and the application of welding to a boiler must be considered from a corrosive point of view. It has been proved that corrosion is electrolytic in character, the positive pole of the small galvanic couples being highly corroded and the negative pole being practically free from corrosion. A piece of boiler steel, when tested for polarity, will show that there are numerous places where corrosion can be set up, due to electrolysis and all the mechanical work upon the iron and steel will immediately start corrosion due to electrolysis, the electrolyte being supplied by the moisture, atmospheric moisture being quite sufficient. A simple experiment will prove this. A piece of steel may be taken which is to all intents and purposes neutral across its entire area. A small hammer or, say, one ounce, may be used for hammering a small portion of this steel. If the sample is then tested for polarity it will be found that a voltaic circuit is present, the stress from the hammered portoin being electro-positive and the original steel being electro-negative; therefore it follows that every rivet head, caulked edge or hammered portion of the boiler is electro-positive to its shell generally. Thermal disturbance and small mechanical work will set up polarity and such a weld will be distinctly electro-positive to the surrounding metal. This is particularly noticeable in machine welded flue tubes in locomotives. Ninety per cent of the corrosion taking place in these flue tubes will always be present where the added length of tube has been made to recover short tubes. Autogenous welding is distinctly electro-positive to the surrounding metal because the added metal is less pure than the original metal, containing magnetic oxide of iron and other impurities. An oxy-acetylene or gas weld made on a pressure tank or boiler may be badly pitted by corrosion. A weld by carbon arc corrodes to a greater extent, and welds by the bare wire pencil method are certainly no better.

I would advise the members of the Committee and everyone here to test this out for himself,—which can be easily done by means of a milli-voltmeter. The deposit by the slag electrode is so very pure (and the photo-micrographs which you have just seen prove this), and the added metal by this process is quite electro-negative in the surrounding metal to a very large degree obviates corrosion at the weld.

There are a number of samples at the end of the room which have been made, perhaps, 18 months or two years ago, and no rust is present in the weld. No care has been taken in the storing of these samples, and the welds have been subjected to atmospheric influences.

I would strongly suggest that in making a decision as to the physical reliability of welding, as appertaining to boilers, that the subject of corrosion be very strongly borne in mind, and I am tempted to say that if this is so forged welding will not be permitted, and some fusion process will be adopted wherein the corrosive influence of an electrolytic circuit is to a very large degree restricted.

Some examples of work done by electric arc welding and the savings brought about by its use. Taken at random from actual shop records, representing cases met with in daily work.

| | Costs | | Time required | Replaced or repaired by | Costs | |
|---|---|---|---|---|---|---|
| Nature of work | Material | Labor | Current | hours | other methods | Material | Labor |
| Crosshead | $0.15 | $0.75 | $0.11 | 2:30 | New crosshead | $ 35.40 | |
| Tank castings | .54 | 3.15 | .40 | 10:30 | New casting | 19.83 | |
| 4 driving boxes | .28 | 1.80 | .21 | 5:00 | Other methods | 1.50 | $ 4.80 |
| 2 link hangers | .08 | .54 | .06 | 1:30 | New hangers | 9.26 | |
| 20 C.S. center plates | .62 | 2.80 | .46 | 8:00 | New plates | 67.40 | |
| 2 C.S. bolsters | .75 | 5.42 | .54 | 14:00 | New casting | 53.38 | |
| 6 cross heads | .30 | 2.00 | .25 | 6:00 | New crossheads | 212.40 | |
| Cracked staybolt holes | .30 | 1.95 | .25 | 5:00 | Sidesheet patched | 26.00 | 48.00 |
| Bad spot frame | .48 | 2.65 | .36 | 8:45 | Frame removed and repaired | 12.00 | 50.00 |
| Crown sheet | .03 | .30 | .03 | 1:00 | Other methods | 40.00 | 35.00 |
| Cracked door sheet | .12 | 1.90 | .10 | 3:00 | Patched | 24.00 | 30.00 |
| Guide yoke | .12 | .70 | .90 | 2:00 | New yoke | 47.00 | |
| 3 superheater units | .06 | .25 | .04 | :45 | New units | 78.00 | |
| Mud ring | .37 | 1.35 | .21 | 6:30 | Smith weld | 13.20 | 16.20 |
| Cracked door sheet | .12 | .30 | .09 | 1:00 | Patched | 24.00 | 30.00 |
| 5 drawhead stops | .18 | 1.15 | 1.30 | 3:50 | New castings | 22.25 | |
| Broken cylinder | .11 | .65 | .80 | 2:00 | Patched | 4.00 | 9.80 |

## HOW SHOULD WELDERS BE GRADED?

In our December issue we published an advertisement asking for opinions from our readers on the proper grading of welders. That is to say, if welders are to be divided into four general classes, from an efficiency standpoint, how shall the classes be separated and what must each class know. We refer readers to the advertisement mentioned. Several suggestions have been received, but for lack of space we are not discussing the subject in this issue, but will continue the discussion in the February issue.

# The Welding Engineer

Published on the First Thursday of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7154.

L. B. Mackenzie.....President and Editor

Subscription payable in advance and postage free.
United States, Canada and Mexico.....$2.00 a year
Foreign Countries ..... 2.50 a year
Single copy, domestic .....20 cents
Single copy, foreign .....25 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations.

Eastern Office, Room 322-E, 30 Church St., New York. Telephone 475 Cortlandt.

We guarantee that of this issue more than 4,000 copies were printed, excluding copies spoiled in press room and bindery. At the time of mailing the known distribution was (actual count always exceeds press order):

| | |
|---|---|
| Copies to paid subscribers | 2,150 |
| Copies to advertisers | 81 |
| Copies to prospective advertisers | 85 |
| Copies to other trade papers, correspondents, etc. | 61 |
| Copies mailed as samples to prospective subscribers | 1,413 |
| Copies retained at office of publication to fill new subscription orders, etc. | 300 |
| Copies for office use | 10 |
| TOTAL | 4,100 |

VOLUME 2. JANUARY, 1917. NUMBER 1.


## We Are With Them.

CHARLES M. SCHWAB, called the modern Tubal Cain by his hosts at a recent dinner, predicted continued prosperity for the steel industry, after the end of the war. As the welding and cutting industry is closely allied with steel, we may in confidence expect a continuation of welding and cutting prosperity if the prediction of this genius of organization is true.

With our feet on the ground and our heads not so high in the air that we are in the clouds, each of us doing our level best in our own particular way for the benefit of the industry, we'll make 1917 a banner year in the history of welding and cutting.

---

## The Labor Question.

IN certain quarters, there has been expressed some fear that the banding together of welders for the purpose of improving the quality of their work by the exchange of ideas, is likely to grow into a labor organization which might later prove inimical to the industry. Poof.

If there is a union of welders or if there isn't, we cannot find any occasion for alarm. Labor will eventually get what it is worth, with or without the aid of a union. In welding, where skilled, conscientious work is demanded, labor is worth and should get a proper compensation which should be properly based upon the law of supply and demand, exactly the same as the price of any other commodity should be regulated. Welders who improve their methods of welding, improving the quality and reducing the costs, will have no trouble in securing positions paying better wages than welders who do not care about their work or take no particular pains to improve their condition. The well paid workman is as a rule a happy workman, an intelligent man and one who is an indispensable in the scheme of factory efficiency. Any organization tending to improve the condition of the workman may pretty safely be considered a benefit to the industry.

## Training for World Service.

THE biggest opportunity ever offered any people for world service has found this nation, because of lack of training and experience, unready to assume in a broadly comprehensive manner the responsibilities and obligations which go with the opportunity. We have reason for congratulation that we have accomplished as much as we have during the last two years. Our export trade, it is true, has more than doubled during the war period, but has this been because of any particular enterprise or exceptional effort on our part? The warring nations have had to draw on this country for food supplies and munitions of war. Other countries, whose former sources of supply in Europe have been shut off, have entered our markets and bought our goods because this country alone could supply their wants. We have experienced a market dominated entirely by buyers, with practically no competition, and a demand, in almost every line, far exceeding our output.

In the filed of international finance, the money lenders of the world have turned borrowers. England, for centuries the world's banker, has resold to us the large part of our securities which she previously held, and with her allies has borrowed hundreds of millions of dollars in our market. The other nations of the world, whose money for development purposes England, France, Belgium and Germany had heretofore supplied, have likewise been forced to turn to the United States for financial assistance. Our foreign loans in 1916 have exceeded two billions of dollars.

But here too we have had things all our own way. We were the only lender in the market, and, without any substantial competition, we have been able to fix our own terms. Distracted nations, under the force of grinding necessity, have literally flung their hoarded gold into our laps. Today we hold nearly one-third of the world's entire known supply of gold. Novices as it were in international finance, we are actually at a loss whether to view this flood of gold as a menace or as a national blessing.

In the field of commercial banking, the whole world is open to us. Dollar exchange in South America is an accomplished fact. Direct dollar transactions with the Far East are no longer a novelty, and commercial credits in dollars are in daily use for the importation of tea from Ceylon, rubber from Sumatra, tin from Malaysia, and wool from South Africa and Australia.

Branch banks have been established in South America, and in Europe. Direct facilities, through the branches of an all-American banking institution, are available for business practically all over the world.

---

## Influencing Future Business.

THE man who says, "I don't have to advertise—I am already oversold"—will do well to consider the statement recently made by one of the most skillful advertising directors in this country, who says:

"If in a period when the product is oversold we should desire to slow up the demand, we would have to exercise some sort of magic whereby we could cancel the advertising which we did last year and the year before that, for we are feeling the effects of that advertising now just as surely, and perhaps more surely than that of the advertising which we are doing at present.

"If we should stop advertising during a period when orders are embarrassing, the only effect would be to slow up the orders a year or two hence when we might possibly like to have them—in fact—be exorbitantly glad to see them come in."

**Quality = *Guaranteed* = Quantity**

***Write US About Your Acetylene Supply***

Commercial Acetylene Welding Co.

ATLANTA, GA.
AURORA, ILL.
BOSTON, MASS.
BOUND BROOK, N. J

80 Broadway, New York City

PEOPLES GAS BUILDING
CHICAGO, ILLINOIS

EAST DEERFIELD, MASS.
TORONTO, ONT.
SAN FRANCISCO, CALIF.
MOBERLY, MO.
W. BERKELEY, CALIF.

# *Hints for the Welder*

*When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way—I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today—the men on the firing line are waiting.*

*L. B. Mackenzie, Editor.*

### EXPANSION—MANGANESE STEEL.

Editor: In your December issue Mr. H. L. Sargent advances a theory that all metals grow by means of expansion. I cannot express an opinion as to all metals, but as to cast-iron it is no longer a theory but a proven fact that it is possible by repeated annealings to increase the size of some castings over 5%. Its specific gravity becomes less, the metal is not so dense but on the contrary becomes quite porous.

In the same issue the Metal Welding and Supply Company request information as to the welding of a thirty-inch crack in a one-inch manganese steel dredge bucket. The writer experimented for about six months with one of the largest makers of manganese steel in an effort to successfully weld this alloy. On very small cracks, we could do fairly well, but on breaks such as indicated in his communication we had no success. This firm had both oxy-acetylene and electric welders and with the arc they finally succeeded in making a very good weld on cracks as long as six inches. Ordinary Norway filler was used, but the rod was coated with a special flux, the composition of which was kept secret, but its object was to protect the molten metal from the air and thereby prevent the manganese in the steel from oxidizing. With the small cracks, as soon as the weld was completed, water was poured over it so that it would cool quickly. This of course is just the opposite to what one would do with ordinary steel, but manganese is not an ordinary steel. On large cracks, it was found necessary to subject them to re-treatment. It may be of interest to know a little more about this rather curious alloy of steel. If the steel contains less than 11% or more than 13% of manganese, it is of no value. This, of course, is a very narrow range and as manganese has a great affinity for oxygen, where it is melted for welding some is going to be burned out, leaving less than 11% behind. If a rod rich in manganese were used it would be pure luck if less than 13% were added.

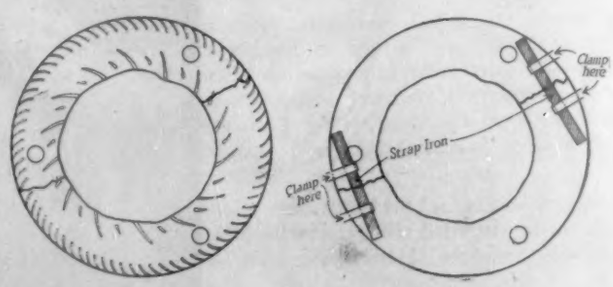
When the steel is cast, it is hard and brittle. What is desired is very great hardness combined with toughness. To this end, the castings are heated white hot and then entirely submerged under water. This treatment leaves the metal not only extremely hard, but also very tough.

P. F. Willis, Pres.,
Henderson-Willis W. & C. Co.

### CIRCULAR CAST IRON PLATES.

Editor: In our shop we pull off some pretty good stunts once in a while and have been rather successful in every thing that has come to us, with the exception of Hot Water Tanks, the galvanized kind used with kitchen stoves, and flat cast iron plates. We do not care any thing about the hot water tanks, as they are seldom worth repairing when they get to leaking, but would like a little information in reference to the cast iron plates. We enclose you a rough sketch of a circular grinder used in a corn mill.

This disc is about 10 inches in diameter, ¼ inch thick, on outside, with large irregular hole near center. The outside on flat surface has small cutting flanges, rather like spiral gear, with larger flanges near the center hole. The flanges are about ¼ inch high on inside and taper down to the metal




on outside. The reverse side of this plate is strengthened by two circular ribs.

We welded it the first time without preheating. In welding one side it pulled the other open, so we put a clamp on it and got it together, but in cooling it broke in the weld. We have since preheated it on the opposite side, then got it red hot all over, then welded it hot and cooled the outside rim with water, and still it breaks. We never give up a job and will weld at it until nothing is left, but as we invariably have trouble with flat pieces of cast iron, would like you to get us some "Know How" in such matters.

We have been buying your paper and a few days ago sent you our subscription—a welder who will not take your paper is a fool.—Southern Welding Company.

Answer: Galvanized hot water tanks may often be repaired by using soft brass wire, ordinary brazing flux, and a decidedly carbonizing flame. They should never be welded, since the zinc not only covers the iron but penetrates into it and a weld without blowholes is impossible. They are many times amendable to brazing, however, and the repair

# HAUCK

**Preheating Torches and Burners**

**Reduce Expense and Make Welding a Success**

**They Sell from $15.00 to $125.00**

Ask for Free Book 77W

***HOW and WHY to Weld and Braze***

**HAUCK MFG. CO., Brooklyn, N. Y.**

# Winfield Spot Welders

Have made for themselves a **reputation,** both for **efficiency** in production and ease of **operation,** with **ruggedness** to stand up under all conditions. Investigate their merits before purchasing.

## The Winfield Electric Welding Machine Co.

**Warren, Ohio**

Specialists in the design of electric welders for every purpose.

**BUTT — SPOT — JUMP.**

Send for new booklet on Welding. It's just off the press.

**No. 2 FIDELITY WELDING OUTFIT**

The most complete outfit for cutting, welding and carbon burning. Will handle practically any work of this nature. Packed in a handsome wooden carrying case, complete with a large assorted stock of welding material.

The outfit consists of:
1 No. 2 Welding Torch (22 in. long) with 10 copper tips.
1 No. 2 Oxygen Long Arm High Pressure Regulating Valve, nickeled throughout, with 3,000-lb. tank and 150-lb. working gauge.
1 No. 2 Acetylene Long Arm High Pressure Regulating Valve, with a 300-lb. tank and 50-lb. working gauge.
1 Heavy Nickle Plated Wrench.
1 Pair Olive Green Gelder's Goggles with gauze face protector.
20 ft. High Pressure Hose with clamps.
Large assortment of cast iron welding rod, brass rod, aluminum rod, low carbon rod, Norway iron rod, manganese bronze rod, cast copper rod, also brass and copper flux, and aluminum flux.
All packed in handsome Wooden Carrying Case, with Instruction Book.

## Welding Apparatus for Jobbers

No. 2 Fidelity Outfit

Ask your nearest Automobile Supply Jobber

There is a Fidelity outfit for every kind of welding, cutting, carbon burning, brazing or soldering. We specailize in complete apparatus for the jobber only.

**Torches—Regulators—Trucks**
***and Supplies of All Kinds***

Fidelity apparatus is made of the very finest materials, under most careful and painstaking supervision. Thousands of our torches are being used successfully in all parts of the United States.

Write for illustrated catalog.

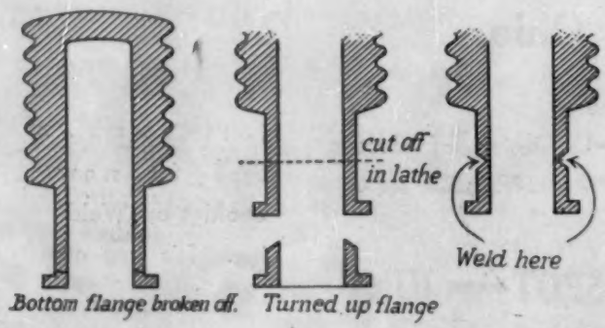
**FIDELITY BRASS MANUFACTURING CO.**
**1009 W. Washington Blvd. Chicago, Ill.**

may be profitable to the job shop. We do not understand what information you require about the cast iron plates. If you will describe the job and send sketch we will try and help you.

Welding thin sections of cast iron is always difficult unless precautions are taken to guard against the rapid cooling of the weld, which may cause severe warpage or fracture, or both. In the disc you describe we would first "tack" the break at one point. Then use a light strap iron running crosswise of the break and clamp it to the disc on each side of the break, putting the clamp a couple of inches from the break. The purpose of this clamp is, please remember, not to prevent expansion, since this is impossible, but merely to guide it; that is to keep the disc from warping. These preparations cover both breaks. Now preheat *each* break for a distance *only* a couple of inches each side of the weld to be made. In this particular instance, we would advise gas flames if you have them and if a charcoal fire is used, have the disc down in the fire on the opposite side to which the strap iron is clamped, since it is not desirable to heat the iron or to have it conduct heat away from the disc. The weld should be made while the section is at the red heat and while the opposite break is also at the red heat and the finished weld held at this heat while the other break is welded and both allowed to cool together. Even heating and even cooling are essential on all thin sections and you must depend upon these methods and not clamps to prevent distortion or fracture. Never in our opinion should water be used to cool cast iron. It is allowable on other metals. —Editor.

## WELDING MOTOR CYCLE CYLINDER.

Editor: I had a broken motor cylinder brought in for repairs. I turned up a new bottom flange, then cut off cylinder and beveled both pieces 45 degrees, then welded it up without preheating.—S. Perkins.




Editor's Comment: Welding of this character is perfectly practical, in so far as expansion and contraction effects are concerned, but is likely to produce a hard weld, due to rapid cooling. It's a safe rule to preheat cast iron whenever possible, to avoid this bad feature.

## WELDING MANGANESE STEEL.

The following remarks, coming from a well known apparatus manufacturer, will interest welders:

"Manganese welding rods are of no service in welding managanese steel. After manganese is hardened any attempts at welding result in reducing its qualities.

A few years ago we spent several thousand dollars on the proposition of welding manganese steel, or perhaps to be more accurate, in attempting to add to railway frogs made of manganese steel a similar material that would hold up against the hard tear of traffic. This has not been successfully accomplished to date, as far as we know. Attempting to weld manganese with manganese would only give about fifty to sixty per cent strength of the original stock. In our shops in welding manganese we used a good Swedish iron (our Titan Welding Rods); we also used a good Tobin Bronze (our Gem Welding Rods), but our attempts in welding were not satisfactory.

"We do repair the manganese lips of large dredge dippers. This work consists in adding metal but, of course, the added metal will not stand as did the original manganese. Consequently, we do not handle manganese welding rods for the reasons given above."

## MANGANESE STEEL WELDING.

Editor: In November you published an article on welding manganese steel. Four years ago I was "up against" a manganese rock bit at a stone quarry. I could readily melt the metal away, but on trying to fuse the metal a white, foaming substance resulted. When trying to weld manganese steel tubes the result was the same. I am skeptical and so are some of my friends. Please have Mr. Kopferschmidt, the author of the article, defend himself, as to how he overcame this difficulty.

In your answer to Mr. McQuaig's question on cutting cast iron you say too much carbon. I have been given to understand that the more carbon the easier to cut. In cast iron the carbon is too free, thus making cutting an impossibility, whereas in steel the carbon is closer, thus making steel cutting easy. Please look into this.—N. Kindler.

Editor's Comment: Relative to the manganese question, Mr. Kopferschmidt says:

"In my article in the November issue, page 19, I dealt only with railroad frogs and diamond crossings, which are generally in the form of half-hard steels, with a percentage of about 0.6 carbon, and only those that are worn out on the face. If Mr. Kindler will send *The Welding Engineer* a rough sketch of the manganese rock bit I will furnish the proper method of repairing same without his being annoyed by the white, foamy substance. Furthermore, manganese steel tubes are weldable and if Mr. Kindler will send in a small specimen I will return same welded, and include my formula."

Relative to our answer to Mr. McQuaig on the cast iron cutting question: Highly carbonized steel, the melting point of which is lower than iron, the oxide of which will melt at or about the same temperature as the iron, will not cut as readily. In like manner cast iron cannot be cut because the iron oxide almost melts at the same temperature as iron, thus the iron oxide produced by the combustion cannot be eliminated from the molten metal.—Editor.

## NO NEED OF PREHEATING HERE?

Editor: When two or three spokes are cracked in a fly wheel, or pulley, heat rim of fly wheel with welding torch to a red heat, at point where broken spokes join rim. Then weld spoke. When weld is finished heat spoke from weld to rim to a dull red. Allow to cool and follow same plan with other spokes, allowing each weld to cool perfectly before starting other welds. When rim of a fly wheel is cracked in more than one place preheating is unnecessary. Weld one crack; allow to cool, then weld other. New teeth can be welded in same manner without preheating.—G. A. Raguse.

Editor's Comment. We believe our correspondent is wrong. Rim should be heated at two points, each side of spoke. We think spoke should not be heated after welding. Heating spoke after welding causes expansion. Expansion should occur *before* welding—not after.

# B-B-B Welding and Cutting Outfit (*Safety First*)

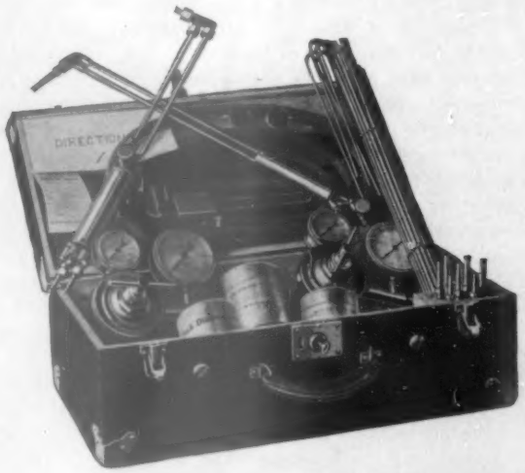
We offer you unlimited opportunities for more business and bigger profits in all kinds of manufacturing and repair work. This outfit is the result of years of study and research by our engineering department; designed to insure the **safety** of the operator; all parts are made chemically as well as mechanically correct. You will be interested in our **Diaphragm Safety Device**; the special construction of our Regulators; and the many new features in the B-B-B Welding and Cutting Torches. This is a high grade outfit for high grade work and **utmost safety**—all parts are dependable, accurate and reliable—it is the outfit you need to get the biggest share of the welding and cutting profits.

***Send for our big complete catalog, showing details of construction, with prices, etc. No obligation to you.***

**THE BISHOP-BABCOCK-BECKER CO.**

**General Offices and Factories, Cleveland, Ohio**

**Branches in the Larger Cities**



**This Complete Outfit Includes**

1 No. 865 Welding torch equipped with seven tips of various sizes; 1 No. 855 Cutting torch equipped with three tips; 15 ft. ¼" 3-ply rubber oxygen hose; 15 ft. ¼" 3-ply rubber acetylene hose, complete with couplings; 1 No. 1307 Oxygen Welding and Cutting Regulator; 1 No. 1327 Acetylene Welding and Cutting Regulator; 1 lb. Cast Iron flux; 1 lb. Copper-Brass and Bronze flux; 1 lb. Aluminum flux; 1 lb. Cast Iron welding rods; 1 lb. Aluminum welding rods; 1 lb. Iron welding rods; 1 lb. Bronze welding rods; 1 Pair Asbestos gloves; 1 Pair Goggles; 1 Wrench; 1 Book of Instructions, all packed neatly in a durable case with lock.

# No. 2 Harris Welding Outfit

*The largest and most advanced line* of high temperature gas apparatus. *Complete installations* for the most extensive manufacturing, metallurgical, chemical and laboratory operations.

**Welding Apparatus**
**Welding Torches**
Oxy-acetylene
Air-acetylene
Oxy-hydrogen
Oxy-natural
Oxy-carbo-hydrogen
Oxy-artificial
Oxy-coal gas
Air-hydrogen
Air-carbo-hydrogen

**Carbon Burning Outfits**
**Cutting Torches**
**Chemical Furnaces**
**Manifolds**
**Atmospheric Burners**
**Acetylene and Oxygen Generators**
**Pre-heating Apparatus**
**Welding Fluxes**
**Fittings**

**Send for New Catalogue**

**THE HARRIS CALORIFIC CO.**

**Established 1905** **Cleveland, Ohio, U. S. A.** **Incorporated 1906**

# "Fyber-Weld" Industrial Goggle

**The Welder's Delight**—Made of fibre—an absolute Non-conductor of Heat. Light and durable.
***No. 510. Fitted with Our Famous Essentialite Lenses*** the exact glass for protecting the delicate organism of sight against Ultra-Violet and Infra Red rays.
**Price $3.00 per pair.**

No. 510. Fitted with Smoke Green Lenses.
**Price $2.00 per pair.**

**Fyber Spectacle**

No. 511. Fitted with Smoke Green Lenses. $1.00 per pair.

No. 511. Fitted with "Essentialite" Lenses. $1.50 per pair.

**Manufactured exclusively by**

**THE CHICAGO EYE SHIELD CO.**

**Safety Dept. No. 33**

**2300 Warren Ave.** **Chicago, Illinois**

### GUN METAL TO STEEL.

Editor: We would like your opinion on the matter of joining gun metal and soft steel together; as to whether it would be better to braze or weld (John P. Ryan, Jr.)

Answer: Gun metal is a composition of copper and tin. Welding it to mild steel then is out of the question, as the melting points of the two metals are at wide variance. It is possible to secure some sort of a braze, but if the bond is subjected to any particular strain we would not advise it. Whether you should or should not attempt to braze it depends entirely upon conditions with which only you are familiar. Not knowing what is expected of the bond we could not advise you. You should at least first experiment with scrap pieces, brazing them together, and then testing the strength of the bond.—Editor.

### WELDING DODGE MOTOR

Editor: Enclosed we hand you a pencil drawing of a Dodge motor block which has a crack as per marks. This is the first job of this kind we have ever had to weld. We have been very successful in all our work. Now the question is, how to go at this job, which way should we preheat it, and which side down; base down or up. The whole bore and all are of cast iron. Which would be the better to preheat with? We have a large gasoline heater torch and also charcoal and could use one or both if necessary. Wm. Trontners.

Answer: We should build a charcoal fire in preference to using a gasoline torch on this job simply because you are better able to get a slow even heat with charcoal.

The break in the water jacket is in a bad location in reference to the bore of the cylinder and this block must be heated very carefully to prevent the crack extending into the bore or of coming close enough to it so that you would warp the bore in making the weld.

We would put the head of the cylinders down, heating slowly with charcoal and gradually building this charcoal up until it nearly reaches the crack in the water jacket. This weld should then be made and allowed to cool. You can then test the cylinders for tightness and if O. K., weld crack in the base by heating in a charcoal fire with the base down. We would not attempt to weld both cracks at the same time because with the same heating you are very likely to get the bores of the cylinders too hot. We are not publishing your sketch because your letter was received too late to make a drawing. Editor.

# TRADE NOTES

### ELECTRIC HOISTS

The Sprague Electric Works, of the General Electric Company, 527 W. 34th St., New York, have issued Bulletin No. 48907, which tells all about 500-pound electric hoists. This little machine is compact, easily operated, and is a factor for economic operation. In the welding shop it would prove very useful and would replace 90 percent of the work now done by heavy cranes. No shop can afford to allow expert operators to use a large part of their time in handling material. This efficient little tool will make the handling of heavy and hot work easy. A copy of the bulletin will be sent on request.

### HOW TO PREHEAT.

An interesting and instructive bulletin (No. 77), has been published by the Hauck Manufacturing Co., 140 Livingston Street, Brooklyn, N. Y., on the subject of preheating, welding and brazing. The bulletin contains a great many very good illustrations, showing not only the well known Hauck preheating torch in action, but illustrating the proper method of constructing fire brick furnaces and protection for welding work. A glance through the bulletin will give the welder a great many ideas as to how to prepare the job properly. A copy of the bulletin will be mailed on request. The Hauck Manufacturing Company also has offices at 537 S. Dearborn Street, Chicago.

---

The Prest-O-Lite Co., Inc., recently used a full page in the *Saturday Evening Post* to tell the adaptability of oxy-acetylene welding.

---

The interests of the Thomson Electric Welding Co., Lynn, Mass., will be looked after in the future by the Thomson Spot Welder Co., in the Middle West. The latter company was formerly the Toledo Electric Welder Co., of Cincinnati. Offices will be maintained at Cincinnati, Chicago, and possibly other cities.

---

Davis-Bournonville Company issue a monthly price list of welding rods, fluxes, carbon blocks, hose, etc., which is sent buyers upon request.

---

The Prest-O-Lite Company has just issued a booklet giving complete instructions for lead burning with the oxy-acetylene flame. It illustrates and describes the apparatus used and gives very concise and clear instructions for operating the torch to burn or weld lead on batteries, sheet metal and pipes.

---

The Compressed Gas Co., Limited, Vancouver, B. C., remembered the trade with Christmas cards.

---

Customers of The Prest-O-Lite Company received in their Christmas mail greetings of the season and a little vest pocket booklet giving some always needed facts for the welder, methods of determining oxygen and acetylene consumption and some timely DO'S and DON'T'S.

---

The National Electric Welder Co., Warren, Ohio, announce that they will shortly market a new line of spot welding machines.

---

The Burdett Mfg. Co. have moved their general offices and factory to 309-19 St. Johns Court, Chicago. The gas plant will remain at 1401 W. Jackson boulevard.

---

### Arc Welding.

The Arc Welding Machine Company, 220 W. 42nd Street, New York, are the publishers of a highly interesting book on the subject of Arc Welding. The book is remarkable for its number of unusually interesting illustrations. Comparisons are drawn between various methods of welding and several comparative tables are given. The price is $1.00.

### THOMSON BUYS TOLEDO.

Thomson Spot Welder Co., Cincinnati, Ohio, which has been recently formed under the Massachusetts laws, has acquired all the patents for the process of spot-welding and spot-welding machines formerly held by the Thomson Electric Welding Co. and the Universal Electric Welding Co. It has also acquired all the physical assets and all the spot-welding patents, etc., of the Toledo Electric Welder Co., Cincinnati, Ohio, which is being liquidated after having been forced into litigation to admit the valdity of the Harmatta patent. The butt-welding machine business formerly conducted by this company has been taken over by the Thomson Electric Welding Co., Lynn, Mass., who will manufacture these machines in the future and look after the needs of the Toledo Electric Welder Co.'s customers.

---

### Tribute to Elihu Thomson.

The *New York Times* recently printed a merited tribute to Elihu Thomson, the father of electric welding. He wears the laurels of many native, as well as foreign societies, and is regarded by scientists as being one of America's greatest inventors.

GENERAL WELDING & EQUIPMENT CO.
G.W.&E.C.
107 MASSACHUSETTS AVE. BOSTON, MASS.

WELDING & CUTTING EQUIPMENTS

PASSED BY INSURANCE AUTHORITIES, USED IN NAVY YARDS AND OTHER IMPORTANT CONCERNS

Our Equipments are designed by the well known
CONSULTING ENGINEER, DR. A. KREBS,
They will appeal to the people who know what they ought to have and what they have been unable to find as yet. We have it.

GENERAL WELDING AND EQUIPMENT CO.
107 Mass. Ave. - BOSTON, MASS.

Welding Plants
FOR
All Purposes
$25.00 to $250.00
Liberal Terms If Desired
Address Department C.
Bermo Welding Co.
Omaha, Nebraska, U. S.

Come to Detroit
The Automobile Center and
LEARN THE AUTOMOBILE BUSINESS

Get into this new business. Big demand for trained men at big pay. Brazing, Welding, and Cutting Shops make big profits. Work comes easily. Business is easy to learn. Work is extremely interesting. You complete course in a short time. Michigan State Auto School graduates get $4.00 to $5.00 a day to start in the brazing departments of the Auto factories. They are taking practically all our graduates. Shops everywhere write us for men at big pay. School open all year. Enter classes any time, any day. Three classes daily, morning, afternoon, evening. Get one of the good jobs or go in business for yourself.

EARN $25.00 to $75.00 A WEEK

Brazing and Welding is the modern way to repair. You get actual experience handling all kinds of metals. Special instructions in Oxy-Acetylene cutting, as used in wrecking steel structures and heavy machinery, included in course.

Sectional View of Brazing and Welding Department

Every student handles the torch—get actual experience and practical training.

Go Into the Business

Big demand for Brazing, Welding and Cutting Shops all over country, as well as demand for trained men. Open a shop for yourself. You repair all kinds of metals for all trades and factories as well as Auto Industry. Farmers, factories of every kind and garages are big buyers of brazing and welding. Write now for catalog and prices of course, or better still, jump on a train and come to Detroit, as others have done. We have no branches. Write or come direct to this school.

MONEY BACK GUARANTEE
We guarantee to teach you Brazing, Welding and Cutting and qualify you to hold a position paying $25 to $75 a week or return your money.

MICHIGAN STATE AUTO SCHOOL
A. G. ZELLER, President
1301 Auto Bldg., 11-19 Selden Ave.,
DETROIT, MICHIGAN

EMPLOYMENT DEPARTMENT
We maintain an employment department and can supply men to manufacturers who need them, or we can place trained men in good positions.

DON'T SCRAP ALUMINUM PARTS
USE SO-LUMINUM Trial Bar 50c.
New—Great—Welding Compound for Aluminum—Does away with weak Aluminum Solders—Perfect substitute for Acetylene Welding—One-half time and Cost. Use gasoline torch—No flux—Guaranteed strongest and best soldering and welding compound in the world.
Full instructions furnished with each order.
SO-LUMINUM MFG. & ENGINEERING CO., Inc.
1790 Broadway Dept. E. New York

M. KEITH DUNHAM
Consulting Engineer
50 Church Street, New York City
Specializing in
*Oxy-Acetylene Apparatus and Use*
Improvement of Equipment Accident Prevention
Redesigning of Manufactured Articles to Meet Welding or Cutting Requirements
Lowering of Operating Costs in Welding or Cutting

ALUMINUM SOLDER
Welding and Cutting Equipment, Generators, Fluxes, Welding Rods and Wires, Brass Foundry Products. May we put your name on our mailing list?
The Ideal Bronze Company
CLEVELAND, OHIO

Oxy Acetylene U.S. Welding Apparatus
Cutting and Decarbonizing Apparatus
Parts and Supplies
UNITED STATES WELDING CO., Minneapolis, Minn.

Superior Welding Torch, Nickel Plated With 7 Copper Tips
SUPERIOR OXY-ACETYLENE MACHINE CO.
1102 East High Street Hamilton, Ohio

This is the Torch You Will Eventually Buy
*WHY NOT NOW?*
Complete Welding, Cutting and Decarbonizing Outfits. Welding and cutting torches, gauges, regulators. Cast iron, aluminum, Tobin Manganese, fluxes, copper, armored and high pressure hose, goggles, etc.
Write for catalog and monthly price list.

### EYE PROTECTION FOR WELDERS.

As every one in the welding industry knows, there is a tendency on the part of welders to disregard the factor of eye protection. This is a subject which should receive the consideration of salesmen and demonstrators, teachers, etc. The first lesson in welding should include instruction in the

"Saved My Eyes Three Times"
Ostrado Ardeni, of the American Smelting & Refining Co., broke three pairs of goggles in ten days. He says: "I will never do anything that is dangerous to the eyes without goggles. They have saved my eyes three times."
Just "Goggles" won't do; be sure they are KING'S SAFETY GOGGLES
Published by
JULIUS KING OPTICAL COMPANY
NEW YORK CHICAGO

**This Is the Sort of Safety First Bulletin Julius King Co. Issue.**

protection of the eyes. In this connection an interesting campaign is being carried on by the Julius King Optical Company, 10 Maiden Lane, New York, which includes a series of bulletins issued monthly and which are intended to be tacked up on the bulletin board, or other conspicuous places in the shop. These bulletins will be sent out monthly to those who send in their names.

### VULCAN CATALOGUE.

Catalogue No. 5, issued by the Vulcan Process Company, Minneapolis, Minn., is unusually attractive, both as regards appearance and information.

It is too complete to call a booklet, as it contains 54 pages, each 6x9 inches, and besides describing Vulcan generators, welding and cutting torches, etc., it lists portable self contained apparatus for plumbers, tinsmiths and hardware men, this equipment being quite new and unique to the trade.

The catalogue lists many accessories, including welding table, shaft clamps, cylinder or tank holder, goggles, gauges, regulators, hose connections, adapters, welding rods, fluxes, etc.

It as well contains a great deal of boiled down information for the welder or prospective welder.

### NEW WILSON CATALOG.

The Wilson Welder & Metals Co., Inc., 52 Vanderbilt avenue, New York, have published Catalog No. 7, which is devoted to the subject of "Electric Welding." The Wilson system is the development of years of experimental work in a large trunk line railroad and much information is incorporated in the book which will be instructive to those interested in welding.

### NEW CYLINDER REGULATIONS.

The Interstate Commerce Commission, on Dec. 4th, announced an amendment of paragraph 1861-(a) of the regulations or the Transportation of Explosives, as follows:

1861-(a). Gases that may combine chemically must not be shipped in one cylinder.

Cylinders manufactured after the date on which specifications therefore were first made effective and used for the shipment of any compressed gas must be made in accordance with the specifications effective at the date of manufacture.

Cylinders purchased after the date on which specifications therefore were first made effective and used for the shipment of any compressed gas must have been made in accordance with specifications approved on or after that date.

# Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

**Wanted—Electric Welder**

Must have had actual experience with arc-welding, both of the metallic electrode and carbon electrode type. Prefer man who has worked in railroad repair shop. The man we are looking for is one who will develop to be a good foreman in a short time; a man who is willing to work, study and develop himself, and be developed.

***Address Employment Office***

**General Electric Company**
**ERIE, PA.**

### GENERATOR FOR SALE.

100 pound Vulcan, used one week, cost $450. Price, f.o.b. New York, properly crated and delivered on cars, $200. Sold for no fault of generator, which is in finest condition and cannot be told from new. Write or wire Welding Supply Company, 132 Nassau Street, New York City.

Welders Wanted—Instructors and demonstrators for oxy-acetylene welding and cutting apparatus; requirements—general railroad experience, including boiler repairs. Address Railroad, care *The Welding Engineer.*

Wanted—Position in East by experienced welder. Address Nelson Baldwin, 335 Market St., Gloucester City, N. J.

Wanted—One expert and three A-1 welders on all metals in job shop. Both extra large and extra small work. Write Clair W. Kelly, 305 S. Washington Ave., Lansing, Mich.

For Sale—Established Oxy-acetylene Welding Business with all equipment, employing two expert welders, Oxweld Apparatus, exceptional opportunity. Reason for selling, leaving United States, must sell before March 1, 1917. Address J-1.—*Welding Engineer.*

Wanted—Salesman to solicit subscriptions to *The Welding Engineer,* or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

# 2-IN-1

## Safety Cylinder Valves

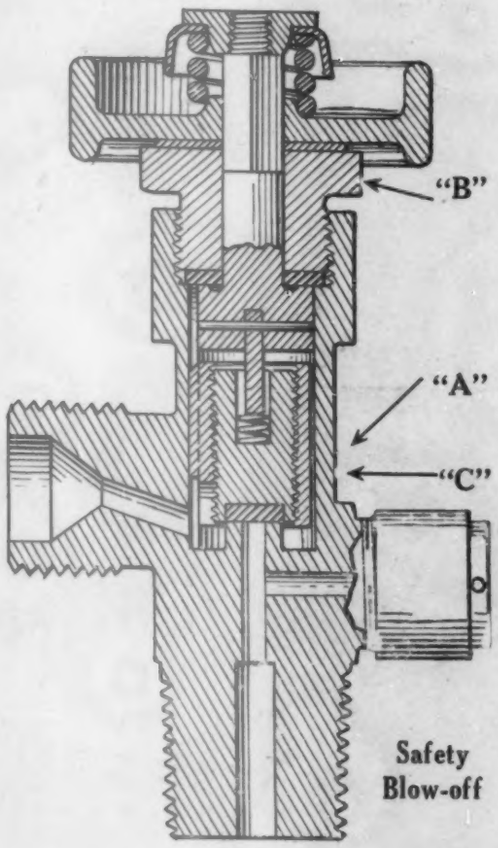
**For Acetylene or Oxygen Cylinders**

Under service conditions acts as check-valve, allowing passage of gas *out* of cylinder *only*.

## Cylinder Readily Prepared For Recharging

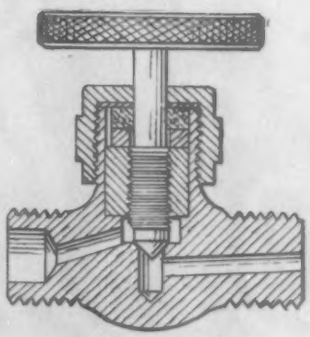
---

When Valve is "open" Loose-Sleeve "A" acts as check allowing passage of gas from, but not into, Cylinder. By backing out Stem "B" as far as it will go Valve "C" is removed from seat and free passage in either direction is obtained.




Patents Pending

# Valve Operates Easily by Hand



Patents Pending

Our Needle Valves, with easy operating and *Re-grinding Features*, are a source of economy, convenience and safety in torch operation. The use of torches with leaking pet-cocks unnecessary.

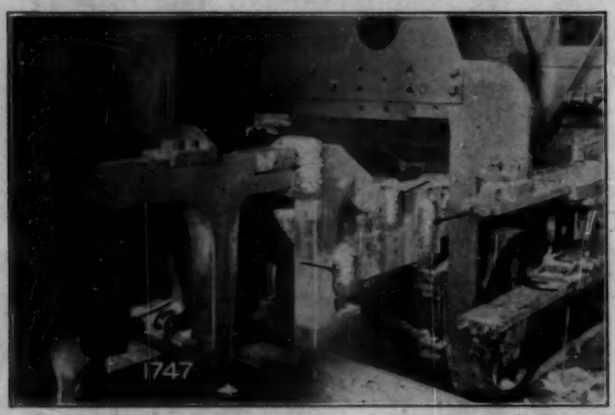
---

# The Bastian-Blessing Company

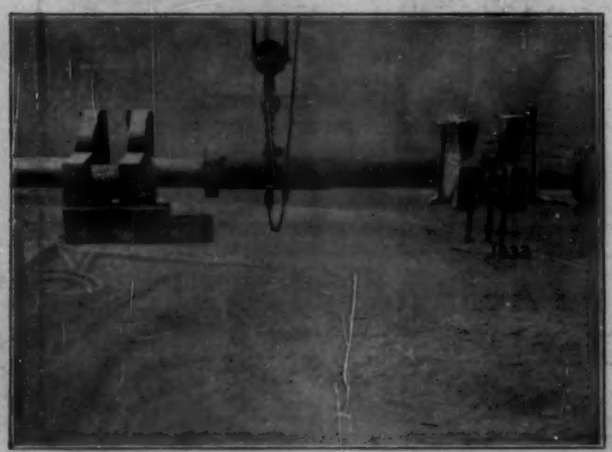
**125-131 West Austin Avenue**
**Chicago, Illinois**

New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.

Large bevel gear on which two new teeth and crack have been repaired.




Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

# We Are Prepared

## To Undertake at a Moment's Notice the Handling of Any Serious Breakdown

Breakage and wear in steel mills and other manufacturing plants has been greater at this time than ever before.

We have been called upon by so many large iron and steel companies recently to make quick repairs to broken rolls and pinions, connecting rods, shears, crank shafts, locomotive frames, and many other sections, the breakage of which often means a serious delay in the operation of the plant, if not a complete shut-down.

Wire or telephone our nearest office and we will proceed at once for arranging the shipment of materials and send an expert to supervise the repair.

We have an eighty-page pamphlet devoted exclusively to this class of work, which is known as pamphlet No. 1779, and tells how the work is executed and how you can do the work yourselves.

## Goldschmidt Thermit Co.

William C. Cuntz, General Manager

Equitable Bldg., 120 Broadway
**New York**

329 Folsom Street, San Francisco — 7300 South Chicago Avenue, Chicago
103 Richmond Street, W., Toronto, Ont.